ECOSYSTEM SERVICES APPROACH FOR ENVIRONMENT DECISION MAKING APPLICATIONS IN THE MEKONG DELTA, VIETNAM

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Ecosystem Services Approach for Environment Decision Making: Applications in the Mekong Delta, Vietnam

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LIST OF ABBREVIATIONS

CA	Correspondence Analysis
CEQ	Council of Environmental Quality
EA	Environmental Assessment
EC	European Council
EDS	Ecosystem Dis-services
ES	Ecosystem Services
FAMD	Factor Analyses of Mixed Data
GIS	Geographical Information System
GPS	Geographical Position System
HCA	Hierarchical Cluster Analysis
MA	Millennium Ecosystem Assessment
MCA	Multi Correspondence Analysis
MES	Markets for Ecosystem Services
NESST	National Ecosystem Services Team
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
PCA	Principal Component Analyses
PES	Payment for Ecosystem Services
PPGIS	Public Participatory Geographical Information System
PPRC	Prawn Rice Rotational Crops
RES	Recreational Ecosystem Services
RS	Remote Sensing
SES	Spiritual Ecosystem Services
TEEB	The Economics of Ecosystems and Biodiversity
UMTNP	U Minh Thuong National Park
UNEP	United National Environment Program
USA	United States of America
USDA	United States Department of Agriculture
USEPA	United States Environment Protection Agency
USFS	United States Forest Service
WTA	Willingness to Accept
WTP	Willingness to Pay
WTT	Willingness to Travel

A B S T R A C T

Human-nature nexuses had been acknowledged by ancient philosophers, for example, Plato who observed the relationships between deforestation and the dying springs in 400 BC. In the form of land, nature's inputs had maintained a core position in the production function, being recognized as non-substitutable components and a physical constraint to growth. However, the industrialization outburst had triggered the dilution of nature considerations, and the complete disappearance in the production function until the following century. This paradigm shift was resulted by the dubious assumption that every natural resource could be eventually replaced by a respectively manufactured capital. Also, the lack of adequate quantification of natural resources in terms comparable to common goods and services could be another reason for the systematic undervaluation. These shortcomings of standard economics in addressing environmental issues had led to the establishment of a new sub-discipline, known as the Environmental Economics since the 1960s. Shortly after, major theoretical divergences within the community of these innovative economists resulted in the second split two decades later, constituting the foundation of Ecological Economics. There are still some debates over how to distinguish these two Economics sub-disciplines. One accepted explanation is the Ecological Economists' conceptualization of the economic system as an open sub-system with exchanging energy, materials, and flows with other social and ecological systems, which fundamentally draws the line. Following the emergence of this new school of thought, there was a growing interest in framing environmental concerns in economic terms to explore human nature nexuses. Also during this time, associated researchers started to refer to ecological, environmental, or nature services to demonstrate how biodiversity deterioration affects ecosystem functions that in turn support human well-being. The term Ecosystem Services (ES) was coined for the first time in 1981 by Erlich and Erlich, followed by an ever-growing body of literature, in which, the first global scale estimation of ES value by Costanza *et al*., 1997 was one of the most significant milestones.

Up to date, the majority of ES research has been conducted in the industrialized countries, thereby resulted in the essential imbalance of useful references regarding ES values in the less developed nations. This gap is significant as much of the global natural resources are located in the latter, and the associated residents are the most likely to suffer from the environment degradation. Hence, a sound understanding of the ecosystems derived benefits is crucial to develop strategies that both preserve natural resources and sustain these people's livelihoods. Reasons for the limited amount of environment assessments in the world's poorer regions are manifold, such as language barriers, policy issues, or more importantly, the missing of practical best-practices guidelines. As a contribution to this particular knowledge gap, this dissertation seeks to report on a trilogy of case studies performed in Kien Giang Province, located in the

South West Mekong Delta of Vietnam. Relevant observations from these case studies are expected to consolidate the current understanding about the ecological profile of the study sites, thereby support sustainable natural resources management. Also, this research targets some important shortcomings associated with ES research and the inclusion of the relevant knowledge in policy planning and decision making within the developing country context.

In Chapter 2, significant findings from the previous peer-reviewed publications were thoroughly examined. This chapter investigates the origins of ES, contemporary approaches to quantify and map different types of services, the associated prospects, and caveats in applying the concept to decision making exercises. The systematic documentation of related findings from the literature is crucial to have an overview of the updated knowledge base, thereby enables appropriate choice of approach methodology for each case study. Also, synthesizing a range of relevant literature helps highlighting specific gaps through expert-based theoretical criticisms and survey-based observations, whereby clarifies the contributions of this research.

In the third chapter, findings collectively acquired from three different case studies are reported. Within the first case study, an integrated assessment of ES associated with the prawn rice rotational crop (PRRC) system in An Minh district, in the South West of the research area was reported. PRRC is among the adaptive measures initiated by the local government of Kien Giang province to mitigate the adverse effects of periodical salinity intrusion to the agricultural production. The specific ES identified include water and nutrients cycling in the soil together with climate regulation in favor of the cultivated crops. A multi-disciplinary approach including remote sensing, GIS, social surveys and statistical analysis was adopted to evaluate the geographical, biophysical, economic van social aspects of the associated ES. Firstly, Landsat 8 images were processed with Normalized Difference Vegetation Index (NDVI) and Modified Normalized Difference Water Index (MNDWI) to identify the PRRC areas. The accuracy of image classification was controlled by ground truth points resulting in 80 % coincidence between the simulated results and the field observations. Secondly, the social survey was conducted using face to face interviews at 50 local households to collect data related to farming practices. Economic values of ES were calculated using the revised market methods by subtracting the total revenue from crop yields with the total associated costs. The mean estimated value of ES provided through the PRRC was 1300 USD/ha/year with the standard deviation of 600, which accounted for 38.1 % and 59.4 % of the averaged economic revenue and net benefit, respectively. The analysis of social survey data revealed the factors having the greatest effects on ES values were selling prices of prawn crops and farming experiences. Finally, the quantification and valuation of ES were synthesized with GIS to describe how ES values vary across the area. Besides the aforementioned technical

findings, the case study of An Minh District also revealed the shortcomings of the effective land pricing system that overlooks the nature's inputs.

The second case study developed and applied a comparative method to measure landscape cultural quality via the assessment and mapping of relevant cultural Ecosystem Services (CES). Three indicators, two survey-based (Richness and Quality of ES), and one GIS-based (Willingness to Travel (WTT)) were proposed to evaluate seven popular tourism sites of Ha Tien Town, located in the North West of Kien Giang province. Primary data collection was done through face-to-face interviews with structural questionnaires at 123 residents' households of Ha Tien. In general, results from CES Richness measurement largely correlate with the popularity status of the landscapes. For instance, the most popular tourism site of the area, Mui Nai has the highest Richness figures, both services, and disservices. CES Quality, via Principal Component Analysis, points to the diverged perceptions among the communities concerning the associated CES, especially between *Ritual Interactions* and other recreational related services. Of equal note are the detected synergies and trade-offs among the evaluated CES via Spearman Spatial Correlation and Correspondence Analysis. These findings could inform policy planners of the attractiveness as well as emerging issues associated with each landscape via social judgments, paving the way to the enhancement of local tourism development. Largely different from CES Richness and Quality, the last indicator WTT relies on the spatial analyst to produce an objective metric for landscape quality assessment. Using Network Analyst tool of ArcMap software, the shortest drivable routes connecting each respondent' household and each evaluated landscape were calculated, then combined with the respective traveling frequencies also collected through the interviews. In general, WTT results are also in line with the two aforementioned measurements in benchmarking the landscape quality. However, two most distant sites with considerably fewer CES were ranked comparative higher in WTT. This finding suggests that there might be some other *hidden appeal* in traveling to those places that the list of CES framed within this study failed to accommodate, *e.g.* communal ties, childhood experience. Nevertheless, with the powerful spatial analyst capacity of GIS, WTT could have offered a reliable and equitable method to evaluate landscape quality besides the popular yet controversial money-based indices, e.g. Willingness to Pay or Willingness to Accept. In a nutshell, findings from the second case study expanded on the understanding of structural links between landscape geophysical attributes derived CES, and the benefits of human wellbeing.

The last case study within the trilogy utilized Public Participatory GIS approach in locating, quantifying and mapping a full list of ES associated with U Minh Thuong National Park (UMTNP), located in the Southern region of Kien Giang. More specifically, the list of evaluated ES includes 5 Provisioning Services (Water, Fishing, Timber, Non-timber forest products, and grass for grazing); 4 Supporting Services (Soil Conservation, Nutrients Cycling, Air Purification, and Habitat); and Cultural Services (Recreation and

Tourism). Alongside, 3 Dis-services, including Fire, Disease, Animal Attacks were also evaluated. The mapping of these (dis-)services was done across four types of Land Covers, i.e. Forests, Grassland, Swamps and Open Water Bodies. In general, Dis-services were recognized to a far lesser extent than services with Disease and Fire being the most relevant concerns. Supporting Services are the most identified, followed by Provisioning and Cultural. Individual service with the most recognition is Habitat, which implies the residents' acknowledgment of this important function of UMTNP. All four category of services and disservices are associated with every land cover, however, with largely diverged patterns. For instance, Provisioning accounts for the most Services associated with Water Bodies, whereas, Supporting are predominant for all other land covers. Cultural and Dis-services, on the other hand, are exclusively associated with Forests. Concerning the diverged preferences towards the evaluated services, Principal Component Analysis followed by Hierarchical Cluster Analysis were used to develop the higher order of representation for the data collected. In general, three largely different groups of preferences were identified. While some demonstrated high regards for the multiple benefits derived from the biosphere reserve, others are not as likely, which potentially leads to conflicts over the utilization and reservation of the shared resources. The depreciating attitudes of some specific individuals, on the other hand, are of particular relevance to illegal animal trapping, water polluting, fires, etc. that have been underscored as standing threats to UMTNP. Another noteworthy finding from these analyses is the relatively underrated Cultural Services compared to the substantial annual revenue from eco-tours. This mismatch implies the need for public awareness improvement. In addition to enforcement or education efforts, it might be as important to involve local inhabitants into the operation of the associated eco-tours, which could gradually nurture the protective behaviors within the community.

In chapter 4, a potential pathway to transfer technical findings from ES research into the policies are presented. Driven by the limitations of the effective land pricing system of An Minh district revealed in the first case study, a thorough review of relevant legal documents was performed, in which, opportunities to apply ES knowledge for improvements were highlighted. More specifically, by referring to the relevant National Decrees that allows for the use of correction factors in land pricing, an ES-based index was suggested to account for the differences in land profitability. The political appraisals performed also included three important national legislations related to the environment protection strategy and sustainable economic development goals. Within these documents, ES related keywords and concepts, such as Payment for Ecosystem Services, Ecosystem Services Structure, Natural Capital, etc. have been used, signifying in the recognition and support of the national government for ES approach in the mainstream decision making agendas. Also, the approach developed herewith has contributed meaningful implications

on how to mainstream technical research outcomes into policy planning and decision making processes, one of the most critical barriers to advancing ES knowledge.

Chapter 5 discusses how to move forward with the ES methodology, analyzing, and inferring via relevant literature and the case studies. In particular, three mismatches, namely the diversity of terminologies, the issue of scales, and the monetization paradox could be the most relevant to the application of ES. About the first mismatch, although frequently criticized as posing barriers to the practical application, the lack of consensus on ES method could reveal opportunities to explore innovative usages in different scientific disciplines, and thus should not be treated as a real barrier. Subsequently, the issues of scales which are associated with both the biophysical scales of ES and the institutional scales of beneficiaries are discussed. In practice, benefits are identified, quantified (preferably in money terms) and aggregated across the research area, regardless of their biophysical scales. For instance, aggregation of Timber production (at the local scale) with Flood Protection (at landscape scale), or even CO2 sequestration (at a global scale) does not constitute any valid information to decision making as the results are double-counted and essentially over-estimated. About the stakeholders' institutional scale, the problems are associated with the emerging conflicts between users over the shared resources. These two have highlighted the requirement for future ES studies to consider scale factors in their problem framing explicitly. Regarding the economic valuation of services, the advantages of monetization were underscored. However, the overreliance on these methods is prone to several risks in decision making, especially in evaluating non-marketed benefits such cultural, spiritual services. In addition to these methodological mismatches, Chapter 5 also takes note of the emergence of analytical frameworks, the combination of ES and other decision-making tools, and the roles of policy actors. In the first section, six characteristics (criteria) of an operational ES framework are summarized. However, it is questionable that purpose wise, satisfying all these criteria with a single model would be impractical and unnecessary. The following section summarizes several prospects in coupling ES knowledge with Environmental Impact Assessment and highlights the current gaps associated the developing country contexts. Finally, to represent the crucial roles of policy actors in ES methodology, two examples with largely contrastive contexts are used. The first one relates to the achievements of the U.S.A. through the 2015 White House Directive which involves the White House Offices and several Federal Agencies in developing, peer-reviewing and applying ES-integrated federal policies and regulations for environmental protection. The second example is the summary of major findings from Chapter 4 of this Dissertation, discussing the opportunities to combine research outcomes from an ES evaluation study to improve the existing land pricing policies.

In the final chapter, all of the contents above are summarized. Also, some recommendations for future studies are also incorporated. Regarding the economic valuation of ES associated agricultural ecosystems,

the inclusion of Dis-services to account for the negative aspects of the cultivation activities are necessary. With specific respect to the PRRC, these components might include the pollution of water via fertilizers, agrochemicals, etc. which had not been addressed in the production function. Also, multi-temporal measurements are also relevant to account for potential variations and consolidate the estimations. Comprehensive assessments as such can be used to communicate about the appropriateness of the current land use policies, and inform corrective measures. The spatial distribution of ES economic values across the landscapes, on the other hand, contribute reliable signals for the management of risks and vulnerability under changing conditions. On the assessment of non-utilitarian ES associated with cultural landscapes that also offer tourism benefits, future studies are encouraged to incorporate the perspectives of not only the local residences but also visitors, especially foreigners. Comparative assessments of anticipations between these two groups of beneficiaries are of particular importance to enhancing the values of tourism products without compromising the ecological balance and the cultural identity of the landscapes. Of equal note is the use of spatial data, e.g., OpenStreetMap, Google Earth; and associated analysis tools, for example, Network analysis to objectively measure the social preferences towards sites with diverse benefits that are either intangible or non-utilitarian. Another noteworthy point is the demonstrated roles of political actors within the overall gameplay of ES. From the achievements of the USA 2015 Whitehouse Directive; to the revealed opportunities in improving land pricing in Vietnam, policy relevance is found to be at least as important as the technical measurements, if not the prerequisite for the applicability of ES in the mainstream decision-making. In other words, researchers should refrain from the notion of staying independent from the social needs and the policy settings. Rather, they are encouraged to design their studies in such a way that scientific findings can resonate deeply with the standards of policies, regulations to facilitate dialogues with decision makers and explore opportunities for improvements.

Chapter 1

Introduction

C O N T E N T S

1.1 Research Background

1.1.1 Origins and Gestation

Not until the final years of the 20th century with the wave of modern environmentalism, had there been a genuine appreciation of land, or more broadly, natural resources. It was observed that: "By the second half of the 20th-century land or more generally environmental resources, completely disappeared from the production function and shifted from land and other natural inputs to capital and labor alone, and from physical to monetary and more aggregated measures of capital, was completed". In particular, within the theory of economic growth during this period, the land had been removed from the production function under the implicit function that nature's inputs could be substituted by manufactured capital (Solow, 1956). This neo-classical economist also highlighted the self-regulatory capacity of markets, arguing that as a particular resource becomes scarce, rising prices encourage consumers to move to alternatives (Solow, 1973). He shortly after stated that "If it is very easy to substitute other factors for natural resources, then there is in principle no "problem". The world can, in effect, get along, without natural resources, so exhaustion is just an event, not a catastrophe" (Solow, 1974).

Mostly, arguments such as those of Solow's have proved to be invalid, and they resulted from standard economics shortcomings in analyzing environmental problems (Gómez-Baggethun *et al.*, 2010). As the irreversible consequences of natural resources overexploitation and their impacts on human well-being grow increasingly undeniable, alternatives that are more environment-friendly become the mainstream. One of the most important keywords to evoke such measures is sustainable, which has flooded many environmental policy discussions. Similarly, countless of books, journals and conferences have added sustainable to their research keywords in fashionable moves.

Nevertheless, measures to realize sustainable achievements in environmental issues have not yet standardized, one of which relates to the ways anthropogenic benefits derived from the ecosystems are perceived, evaluated and preserved. In the efforts to better portray the human-nature nexuses, the concept of Ecosystem Services was introduced based on the literature foundations of the societal value of nature's functions (Ehrlich and Ehrlich, 1981). In fact, the

references concerning ecosystem functions could be made to primary ecology literature, in which the term refers to the set of processes operating within an ecological system, irrespective of if such processes are beneficial to humans (Loreau *et al*., 2002). However, in the late 1970s, various scholars began to address how these functions can be of relevance to human societies, for instance, King (1966), and Helliwell (1969). Accordingly, in the following decades, a growing number of authors started to frame environmental issues using economic terms in the efforts to stress human dependence on natural resources (Gómez-Baggethun *et al*., 2010). Within this movement, one of the ES closely related concepts, the natural capital was first coined by Schumacher (1973). Shortly after, ecosystem (or ecological, or environment, or nature's) services began to be referred by several scholars (Westman, 1977; Ehrlich and Ehrlichn, 1981; de Groot, 1987)

1.1.2 Definitions and Classifications

With the associated literature body, Ecosystem Services (hereinafter stated as ES) are *usually perceived* as those processes of an ecosystem or part of an ecosystem that can provide benefits to human (Costanza *et al*., 1997). Alternatively, Boyd and Banzhaf (2007) sees ES as components of nature directly enjoyed, consumed or used to yield human well-being. Alternatively, more literally stated, ES can be consumables such as the timber from the forest, the fish from the ocean or services such as the prevention of soil and coastal erosion by vegetation (Eamus *et al*., 2005). According to the Millennium Ecosystem Assessment (MA), 2005 the benefits that ecosystems are providing our society could be broadly classified as three categories, including:

- Provisioning services (*e.g*., Food, water, timber),
- Supporting services (*e.g*., Pollination, soil formation),
- Regulating services (*e.g*., Climate regulation, water purification),
- Cultural services (*e.g*., Spiritual, religious, educational values).

There are several alternatives to MA taxonomy, such as the slightly different one suggested by de Groot *et al*., 2002 to account for habitat benefits. Wallace (2007) adopted an essentially diverge classification approach based on the flows, rather than the attributes of services, which was shortly later contended by the necessary of multiple classifications by Costanza (2008). In fact, the mist of both definitions and classifications of ES themselves has been highlighted by many as an

important methodological challenge. Within the scope of this dissertation, the author also thrives on addressing this issue with his own findings, from both literature review and survey-based observations.

1.1.3 The need for Ecosystem Services Valuation

The definitions of ES, regardless of their lexical differences, all convey a fundamental truth: human well-being depends on the sustainable provisioning of these services in many ways. Therefore, they should bear both non-economic and economic values. The emphasis on welfare and human well-being of the concept essentially sets the need for economic analysis along with purely biophysical analysis (Banzahf and Boyd, 2005). However, ES values, in general, have never been fully captured in markets to compare with other economic services, hence the relatively smaller weights in the decision-making process (Costanza *et al*., 1997). This bias would ultimately lead to the compromise of essential nature's inputs and the sustainability of society eventually. As largely contrasted with Solow's belief, human manufactured capitals essentially cannot match the degradation of global ecosystems. Hence, a sound understanding of ES values is essential for better resources management and preservation.

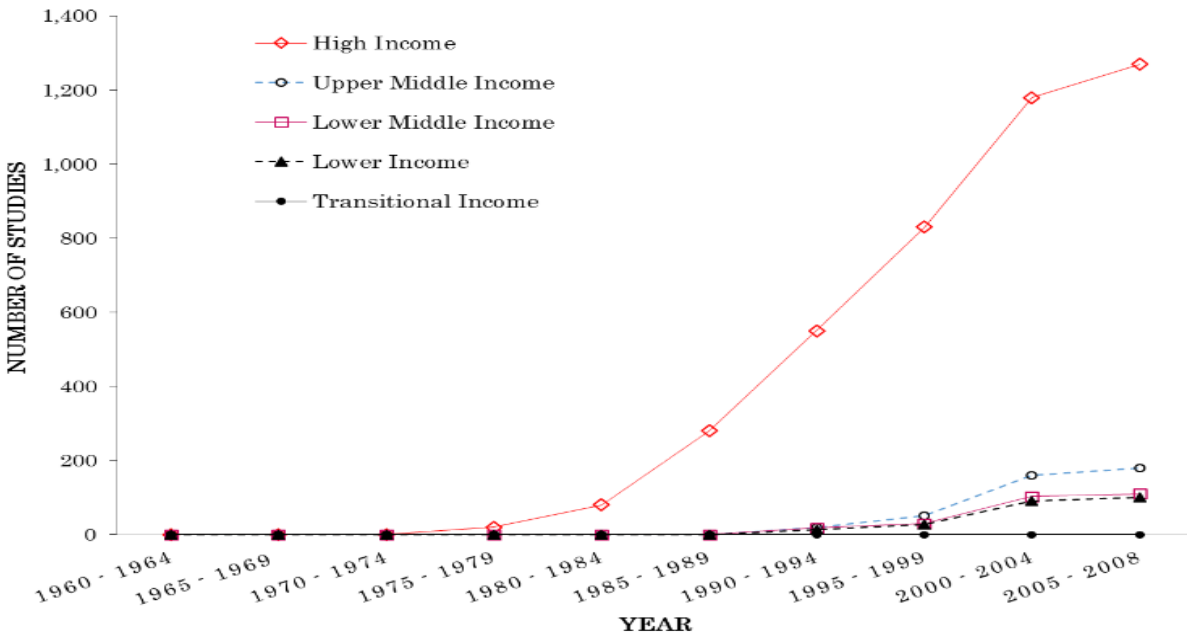
Many attempts to evaluate ES, mostly in monetary terms, have been performed in the last decades. In his iconic paper, Costanza *et al*. (1997) assigned values in dollars to 17 identified ES for the global ecosystems. In particular, Nutrient Cycling was calculated at 3677 US dollars per hectare per year for coastal biome, or water supply of lakes and rivers was worthy of 2177 US dollars per hectare per year. These results that attracted countless applause and critiques, ultimately, could only be taken with a pinch of salt given the complicated, yet unexplored interrelationships between the ecosystems and their associated services within the scope of the study. The primary objective of ES evaluation is, nevertheless, not to stick a price tag to each of the ES but to help decision makers realize the effect of a marginal change or absence of the provision of ES in terms of a rate of a trade-off against other marketed commodities (Turner *et al*., 2003). The realization of such absence could bring about massive economic and the inextricable link between human lives, and ecosystem health is far more crucial than the monetary numbers themselves. In other words, ES valuation is not an end, a noun, but rather the beginning of a

whole range of opportunities, an adjective. The successful assessment of ES could open doors to effective communications about environmental issues to policy makers, hence create sustainable changes.

1.2 Problem Statement

1.2.1 Geographical imbalance among ES studies

Much of the global natural resources are located in the less developed countries (LDCs), and people from these poorer regions would suffer the most from environment degradation (MA, 2005). Therefore, a sound understanding of the relationships between the environment and the benefits provided to society is essential to develop policies that both preserve natural resources and sustain the people's livelihoods in LDCs.



Source: Christie et al., (2012)

Fig. 1.1 Cumulative amount of studies from 1960 to 2008 (indexed in EVRI)

Over the past few decades, a range of methods has been developed to objectively measure the multiple benefits that humanly derives from the environment. Most of these research, however, have been performed in the most developed countries (MDCs), and data on the ES value of LDCs are virtually missing from the literature (Georgiou *et al*., 2006). More specifically, the systematic literature search performed by Christie *et al*. (2012) within the Environmental Valuation Research

Inventory (EVRI) reveals a significant imbalance regarding the number of ES valuation studies conducted between nations with different economic statuses. From 1684 English-written publications successfully identified within EVRI, the majority of studies was performed in the MDCs (88.4%). Only 11.6 % of the studies were conducted in the LDCs, with 94 studies from lower middle income and 101 from lower income nations and no studies from transitional economies (Fig. 1.1). Within the limited amount of published work in the least developed countries, a significant proportion appears to have been undertaken with led by author(s) from a developed country.

What makes environmental valuation in LDCs such a challenging task are manifold. Besides methodological difficulties such as literacy and language barriers, or lack of research capacity, policy related issues, including the lack of awareness of or commitment to the importance of nature' inputs, contribute a full spectrum of barriers (Christie *et al*., 2012). Pragmatically, when societies either do not value nature or are obsessed with short-term economic growth, the introduction of ES and the likes to mainstream decision making runs the risk of becoming trivial (Daily *et al*., 2009). At the same time, the missing of best-practice guidelines, for instance, the validity of utilitarian assumptions for non-use values in developing social contexts challenges the accurate measurements of ecosystem benefits in LDCs.

1.2.2 The selection of study sites

Guided by the knowledge gap mentioned above, this dissertation seeks to report on a trilogy of case studies performed in Vietnam, located in the Lower Mekong Basin. The findings of this dissertation are of particular relevance to the reference paucity of environmental valuation in LDCs given the developing economy background of Vietnam, plus the country persistent overlooks of environmental conservation for economic growth goals resulted from several decades of civil wars. However, a recent major shift of paradigm that realizes the importance of nature' inputs recently documented in national legislations is specifically meaningful to include results from environmental assessment, *e.g.*, the measurements of ecosystem benefits, in the mainstream decision making. Under the umbrella of this institutional move, robust quantification and reliable economic valuation of ES become not only of academic accomplishment but policy

relevance as well, thus the transferability of associated research findings to environmental decision-making processes. The opportunity for the application of environment benefit measures, as sought by ES approach also relates to the increasingly tangible impacts of climate change to Vietnam, for instance, the increasing severity of floods, droughts, or storms. Given the major contributions of agricultural sectors, discussions on potential adverse effects of El-Nino and La-Nina, which are expected to deliver critical hits to both people's wellbeing and the national economy have become more prevalent in both academia and policy agendas.

The case studies reported within this dissertation were conducted across a coastal province known as Kien Giang, with close hydrological relevance to the larger Mekong River Basin through the interlocking systems of tributaries, streams, and canals. There are three main reasons for this site selection, namely:

- With diverse topographical landscapes, ranging from mountains, delta plains, to islands, Kien Giang supports various important ecosystems, especially the ones associated with U Minh Thuong biosphere reserve, which UNESCO has recently recognized as globally important for ecological preservation (See Box 3.2). Also, given the relatively convenient access, the area attracts a considerable amount of domestic and international visitors every year through the renowned collection of scenic landscapes, diverse ecosystems, and cultural richness. These conditions collectively constitute important research opportunities for the assessment of ecological and cultural benefits in developing community context.
- The rapidly developing economy of the area is very diverse, including agriculture, horticulture, aquaculture, and tourism. There have been reports (unpublished) about social conflicts from resources sharing between sectors with different demands, for instance, between rice and prawn cultivations, or between heritage conservation and tourism development, *etc.*, each of which needs appropriate address and resolution.
- In 2011, Vietnam National Mekong Committee consultancy conducted a project entitled "Preliminary study on climate change adaptation plan for Kien Giang" to support the provincial government in developing the Action Plan addressing Climate change issues under the National Target Program. Results from numerical modeling of this project were able to identify areas vulnerable to floods and salinity intrusion under several projected scenarios. Hence, precise

quantification and valuation of the ecosystems, and the associated benefits under pressure could make meaningful follow-ups contributions.

1.3 Research area

Kien Giang is a coastal province, located in the North West of Mekong Delta, with a natural area of 6,347 km^2, with the geographical coordinates identified as 105^{0}30′ to 105^{0}32′ East longitude and 9^{0}23′ to 10^{0}32′ Northern latitude. The province is adjacent to:

- Cambodia to the North through 54 km border line,
- An Giang, Can Tho, and Hau Giang provinces in the North East,
- Ca Mau, Bac Lieu, in the South,
- The West Sea and the Gulf of Thailand in the West with 200 km of coastline.

Regarding hierarchical administration system, Kien Giang has one provincial city (Rach Gia), one provincial town (Ha Tien), and thirteen rural districts (including two islands, Phu Quoc and Kien Hai) as depicted in Fig 1.2. However, the scope of this dissertation only covers the mainland proportion, given the limited resources.

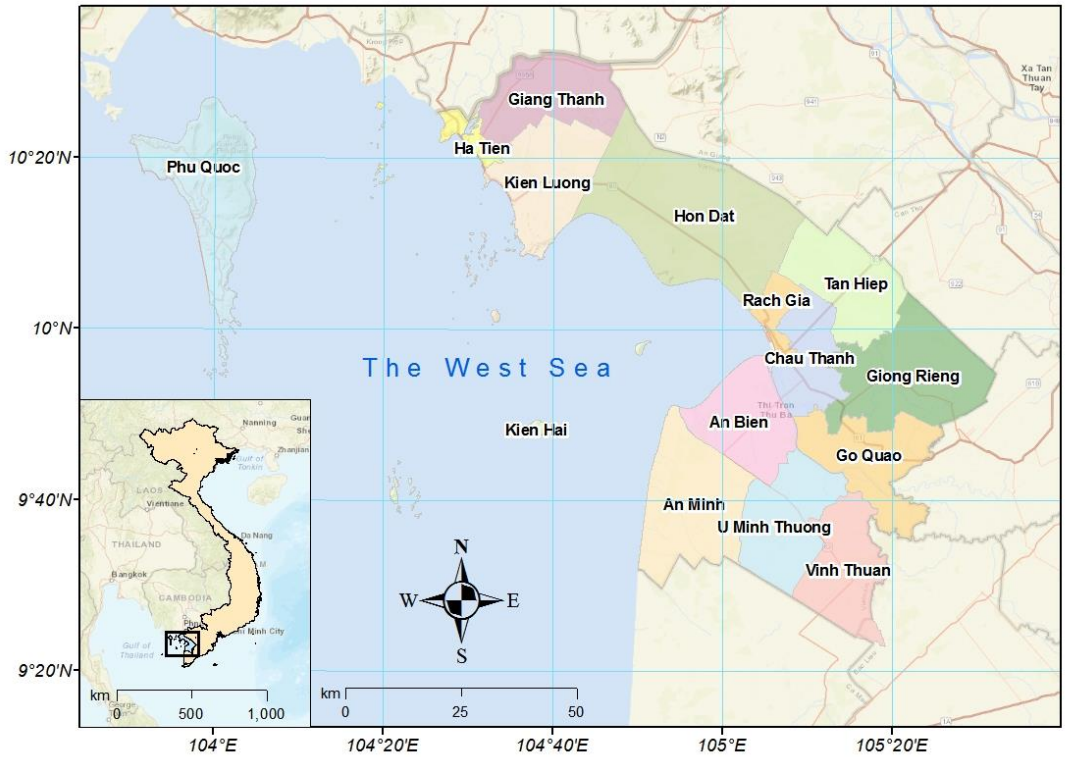


Fig. 1.2 Geographical location of Kien Giang

Kien Giang province has relatively diverse landscapes, including mountains, deltas, and islands of various sizes. The mainland terrain is relatively flat, which gradually lowers from the North-East (with the mean elevation of 0.8 – 1.2 m) to the South West (with the average elevation of 0.2 – 0.4 m). Besides three major rivers, namely Cai Lon, Cai Be, and Giang Thanh, the province also has a dense network of streams and canals with the total length of 2,000 km that are necessary for domestic uses, irrigation, water transportation and flood control. On the meteorological conditions, the research area is characterized by monsoon tropical and sub-equatorial climate, with two distinct seasons, namely rainy and dry (December to April), and rainy seasons (May to November). The average annual rainfall volume is 1,800 – 2,200 mm, in which 90 – 95 % is contributed by the seven months of rainy seasons. Likewise, air humidity differentiates between dry and rainy months. In particular, dry months usually come with 75 – 81 % of air humidity that is 5 % lower than another period.

The abundance of water resources and the mild meteorological regime are favorable conditions for the agricultural development of Kien Giang, in particular, the cultivation of paddy and other subsidiary crops. However, there are emerging risks of floods and inundation resulted from the combination of heavy rainfall and tidal surges, especially in the lower areas. Plus, salinity intrusion is also a consistent concern during dry seasons, during which the depletion of water level on the main rivers can lead to the critical shortage of fresh water for paddy fields.

1.3 Research Objectives

Built upon the theoretical background of ES, the knowledge gaps explored within the literature, and the specific needs of the research area, three research objectives are set for this dissertation, including:

(1) To deliver relevant findings with regards to the quantification, valuation and spatial distribution of relevant ES across the study sites;

(2) To support decision making about environmental issues of the local authority through valid measurements of the local ES;

(3) To contribute meaningful references, both regarding specific observations and practical guidelines for future ES studies associated with the developing context;

1.4 Methodological framework

To achieve the targets above, a detailed methodological framework as illustrated in Fig 1.3 was adopted. In particular, theoretical background of ES approach, problem statement, general information about the research area, and most importantly, research objectives are presented in Chapter 1. In the following chapter, the author made efforts to review and summarize the most relevant findings from the existing literature. The knowledge base of ES, which is relatively new, is still under construction. Practitioners from a variety of disciplines have been consistently contributing to the consolidation of the concept structures and practical guidelines, making it more challenging to adopt a profound and systematic literature review. Therefore, besides an overview of the available techniques in evaluating and mapping different ES, Chapter 2 also investigates the ecological and economic roots of ES. Of equal note are the highlights of some major prospects and caveats associated with the application of ES in decision making.

Chapter 3 continues with the documentation of three case studies, which address different aspects in mainstreaming the valuation of nature's inputs into environmental decision making. In particular, the first study presents an integrated evaluation of ES associated with prawn-rice rotational crops in An Minh commune. The second study seeks to promote the use of OpenStreetMap data, combined with GIS, and field surveys to generate a trilogy of socio-geographical Indicators for the Quantification & Valuation of Cultural Ecosystem Services of Ha Tien town. The last case study reports on the application of Public Participatory GIS to explore the ES profile of U Minh Thuong Biosphere Reserve as perceived by residents. Descriptions of the study sites are available in respective sub-sections within this chapter.

Chapter 4 builds upon the scientific findings of the case studies, especially the first one to explore how the expert-base results can be of relevance to the current policy settings of the research area. More specifically, positive implications, as well as emerging barriers in bringing ES valuation results closer to decision making within the particular developing context are discussed. Also within this chapter, the current profile of the world's ES integrated legislations are briefly reported via a literature mini review effort.

Relevant references from the literature review, combined with the observations collectively acquired through the implementation of three case studies constitute the contents of Chapter 5, in which, ways forward for future ES research are discussed. The dominant outlook of this chapter, and the whole dissertation alike lies in the treatment of ES valuation as a useful means to realize environmental sustainability through well-informed decision makers. Therefore, within this chapter, six relevant sub-themes were subsequently explored, including the consensus of terminologies, the multiple issue of scales, the monetization paradox, the prevalence of analytical frameworks, the integration of ES into the existing decision support tools, and the interplay of policy actors. Lastly, Chapter 6 summarizes significant findings of the complete research and suggests relevant research questions for follow-up studies in the future.

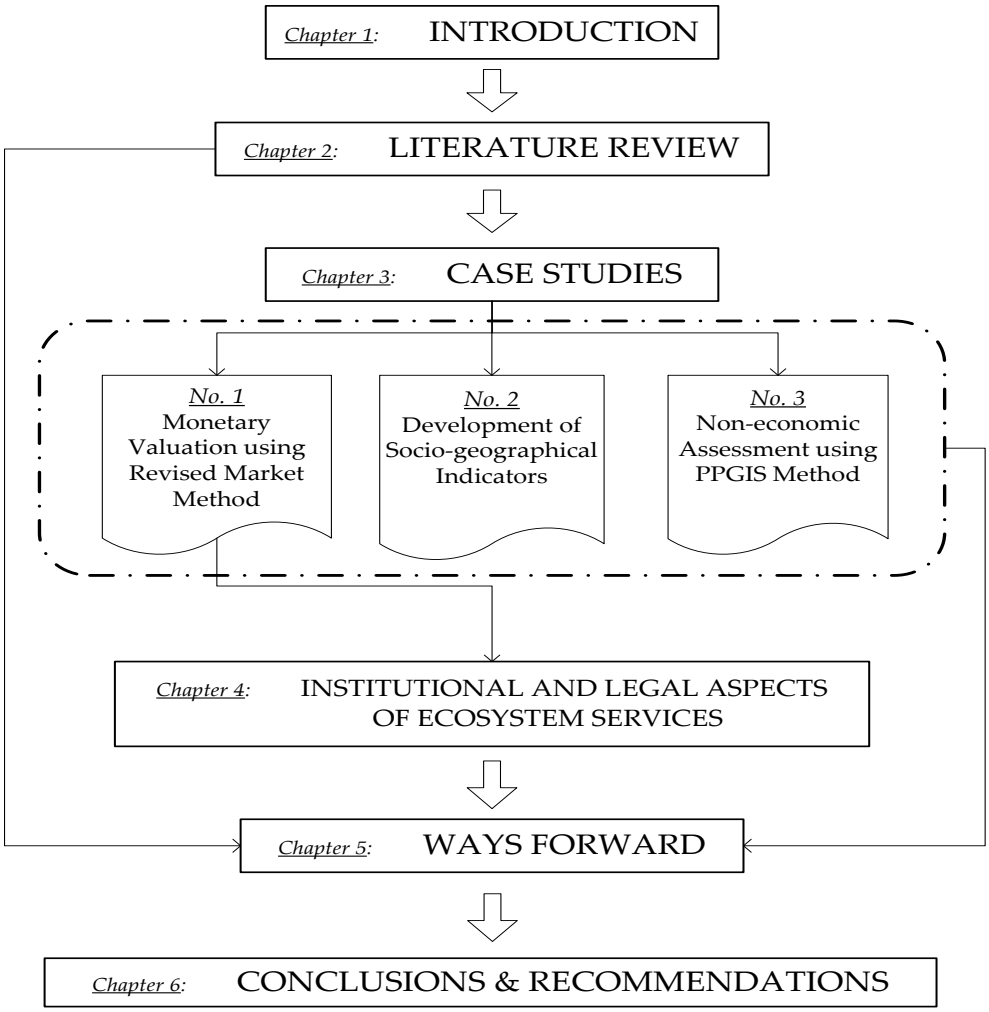


Fig. 1.3 Schematic Diagram of Research Methodology

References

Boyd, J. and Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, 63(2-3), pp. 616–626.

Christie, M., Fazey, I., Cooper, R., Hyde, T., Kenter, J.O., 2012. An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. Ecological Economics 83, pp. 67–78.

Costanza, R., 2008. Letter to the Editor Ecosystem services : Multiple classification systems are needed. *Biological Conservation*, 141(2008), pp. 350–352.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, G.R., Sutton, P., van der Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, pp. 253–260.

Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J. and Shallenberger, R., 2009. Ecosystem services in decision making: Time to deliver. *Frontiers in Ecology and the Environment* 7, pp. 21–28.

De Groot, R.S., 1987. Environmental functions as a unifying concept for ecology and economics. *The Environmentalist* 7 (2), pp. 105–109.

de Groot, R.S., Wilson, M.A. and Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, 41(3), pp. 393–408.

Eamus, D., Macinnis-Ng, C.M.O., Hose, G.C., Zeppel, M.J.B., Taylor, D.T. and Murray, B.R., 2005. TURNER REVIEW No. 9 Ecosystem services: an ecophysiological examination. *Australian Journal of Botany* 53, pp. 1–19.

Ehrlich, P.R. and Ehrlich, A.H., 1981. Extinction: the causes and consequences of the disappearance of species. Random House, New York.

Georgiou, S., Whittington, D., Pearce, D. and Moran, D., 2006. Economic values and the Environment in the Developing World. Edward Elgar, Cheltenham

Gómez-Baggethun, E., de Groot, R., Lomas, P.L. and Montes, C., 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecological Economics* 69, pp. 1209–1218.

Helliwell, D.R., 1969. Valuation of wildlife resources. *Regional Studies* 3, pp. 41–49

King, R.T., 1966. Wildlife and man. New York *Conservationist* 20 (6), pp. 8–11

Loreau,M., Naeem, S. and Inchausti, P. (Eds.), 2002. Biodiversity and EcosystemFunctioning: Synthesis and Perspectives. Oxford University Press, Oxford

MA (Millennium Ecosystem Assessment), 2005. Ecosystems and human well-being: Synthesis. Island Pres, Washington D.C. World Press Institute.

Schumacher, E.F., 1973. Small is Beautiful: Economics as if People Mattered. Blond and Briggs, London.

Solow, R.M., 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics* 70, pp. 65–94

Solow, R.M., 1973. Is the end of the World at hand? *Challenge* 2, pp. 39–50

Solow, R.M., 1974. The economics of resources or the resources of economics. *American Economic Review* 64 (2), pp. 1–14

Turner, R.K., Paavola, J., Cooper, P., Farber, S., Jessamy, V. and Georgiou, S., 2003. Valuing nature: Lessons learned and future research directions. *Ecological Economics* 46, pp. 493–510.

Vietnam National Mekong Committee. 2011. Preliminary Study on Climate Change Adaptation Plan in Kien Giang Province. Final Report.

Westman, W., 1977. How much are nature's services worth? *Science* 197, pp. 960–964.

Chapter 2

Literature Review

CONTENTS

2.1 Development History

There are a variety of definitions for ES evolving through the associated body of literature. Some of the most widely cited ones at present include:

- ES are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life (Daily, 1997)
- ES are the benefits human populations derive, directly or indirectly, from ecosystem function (Costanza *et al*., 1997)
- ES are the benefits people obtain from ecosystems (Millennium Assessment Ecosystem Assessment (MA, 2005)
- ES are components of nature, directly enjoyed, consumed, or used to yield human well-being (Boyd and Bahnzaf. 2007)
- ES are the aspects of ecosystems utilized (actively or passively) to produce human well-being (Fisher *et al*., 2009)

The term ES was first used by Erlich and Erlich, (1981), the origins of the modern history of the concept, nonetheless are to be found in the late 1970s with the utilitarian framing of nature associated benefits as *Services* to attract public support in conserving biodiversity (Westman, 1977; Erlich and Erlich, 1981; de Groot, 1987). The mainstreaming of ES in the scientific literature continues in the late 1990s with notable contributions, for instance, Costanza and Daily, 1992; Perrings *et al*., 1992; or Daily, 1997; emphasizing the methods to assess their economic value (Costanza *et al*., 19997). The following decade witnessed various attempts to bring forth the concept into policy making agendas, landmarked by the publication of one of the most comprehensive and commonly cited literatures, the MA, (2005). At present, with the widespread adaptation and promotion of economic valuation methods by The Economics of Ecosystem and Biodiversity (TEEB). 2010), and relevant Market-Based Incentives, including Markets for ES (MES) by Bayon, (2004), and Payments for ES (PES) by Pagiola, (2008), ES knowledge has been brought significantly closer to decision making. To better understand the rationale of ES applications, the following discussions subsequently take relevant notes on the concept roots in ecology, economics and the fusion of both.

2.1.1 Ecological Roots

Long before ES, the interconnectedness between man and his living environment had been well noticed by ancient philosophers, for instance, Plato's descriptions of the effects of deforestation on soil erosion and the dying of springs in 400 BC (Daily, 1997); or Pliny the Elder's observations of the links between deforestation, rainfall and torrents occurrence in the first century AD (Andréassian, 2004). Several centuries later, Marsh's book: Man and Nature (1864), in the same manner, pointed to the finiteness of America's natural resources, which was later described as the starting point of the ES modern history (Mooney and Ehrlich, 1997). Fundamentally, the concept of ES builds on the predecessor observations of the value of nature's functions to human well-being (Braat and de Groot, 2012).

The ecosystem can be regarded as the fundamental ecological unit (Lindeman, 1942). As such, *ecosystem functions* was originally used to define the set of natural processes operating within an ecological system, regardless of if such processes are beneficial to humans (Odum, 1956). However, in the late 1960s, the term "functions of nature" began to be associated with the "work done, space provided, and goods delivered to humans" (Helliwell, D.R., 1969; Odum, 1971), which caused major confusions as the term by then had been strictly used in ecological sense (Braat and de Groot, 2012). Essentially, a number of processes have to be sustained for the existence of ecosystem itself before any human benefitting services can be generated and derived.

2.1.2 Economic Roots

Natural capital, in the form of land, maintained a core position in Classical Economics analyses, mostly through its recognitions as a non-substitutable production input and one of the physical constraints to growth (Costanza and Daily, 1992). Other than those, the extent to which the intangible benefits derived from nature was acknowledged during this time remains unclear. In principal, classical economists took note on the contributions of natural agents or natural forces only through their use values, while denied the conformation of exchange values as these goods and services were largely perceived as free, non-appropriable gifts of nature. This mainstream mindset was concisely stated by J.B. Say: "*the wind which turns the wind which turns our mills, and even the heat of the sun, work for us; but happily no one has yet been able to say, the wind and the sun are*

mine, and the service which they render must be paid for" (Say, 1829). Essentially, when the benefits obtained from ecosystems were abundant, which was obviously no longer the case, their marginal or exchange value was zero.

The 19th Century witnessed the outburst of industrial growth, technical development and capital accumulation that triggered the dilution of nature considerations in economic analyses. There were lone voices that raised the concern about the external effects emerged from the depletion of natural resources could have on future generations (reviewed by Martínez-Alier, 1987). However, the interest on natural resource considerations of economists, in general, had progressively languished during the first half of the 20th century (Crocker, 1999). The scope of conventional analyses, as a result, was restricted to those goods and services that had been previously monetized, ignoring all of the ecosphere components bearing no exchange value (Naredo, 2003). The second half of the 20th thus witnessed the complete disappearance of land or more generally environmental resources from the production function, and the shift from natural inputs to capital and labor alone, from physical to monetary and more aggregated measures of capital (Hubacek and van der Bergh. 2006). This fundamental shift in paradigm was fueled by the implicit assumption that every nature's inputs could be eventually substituted by manufactured capital (Solow, 1956).

Also during this time, with the wave of modern environmentalism, specialized economic sub-disciplines started to address the shortcoming of conventional economics in analyzing environmental problems. Notable in these emerging schools of thought was Environmental Economics, which argues that pure neoclassical economics largely neglect the economic contribution of nature by restricting its scope of analysis to those ecosystem goods and services that bear a price. Hence, the systematic undervaluation of the environmental dimension in decision making would be partly explained by the fact that the services provided by natural capital are not adequately quantified in terms comparable with economic services and manufactured capital (Costanza *et al*., 1997). In other words, if valued in monetary terms, non-marketed contributions of ecosystems can be incorporated in economic decision making. Guided as such, the Environmental Economics literature has developed a range of valuation methods to

account for external environmental costs and benefit (Gómez-Baggethun *et al*., 2010). Some of these methods are still widely used by the ES community at present, for instance, hedonic pricing (Ridker and Henning, 1967); travel cost (Clawson, 1959); or the contingent valuation method.

Major theoretical divergences within the Society of Environment and Resource Economists led to a split in the late 1980s, which constitutes the foundation of what we know today as Ecological Economics (Costanza, 1991). Although largely identical to the employed methods to measure sustainability, evaluate policies and support decision making, these two economic approaches largely differ in the operational frameworks. Ecological Economics essentially challenges the assumptions of the neoclassical inherited framework of Environmental Economics of consumer choice, perfect information, *etc*., and conceptualizes the economic system as an open ecosphere sub-system exchanging energy, materials, and waste flows with other social and ecological systems with which it co-evolves (Daly, 1977). With regard to the treatment of *sustainability*, Ecological Economists advocate on the *complementarity*, rather than *substitutability* relationship between natural and manufactured capitals, which as one of the important cornerstones of Neoclassical Economists.

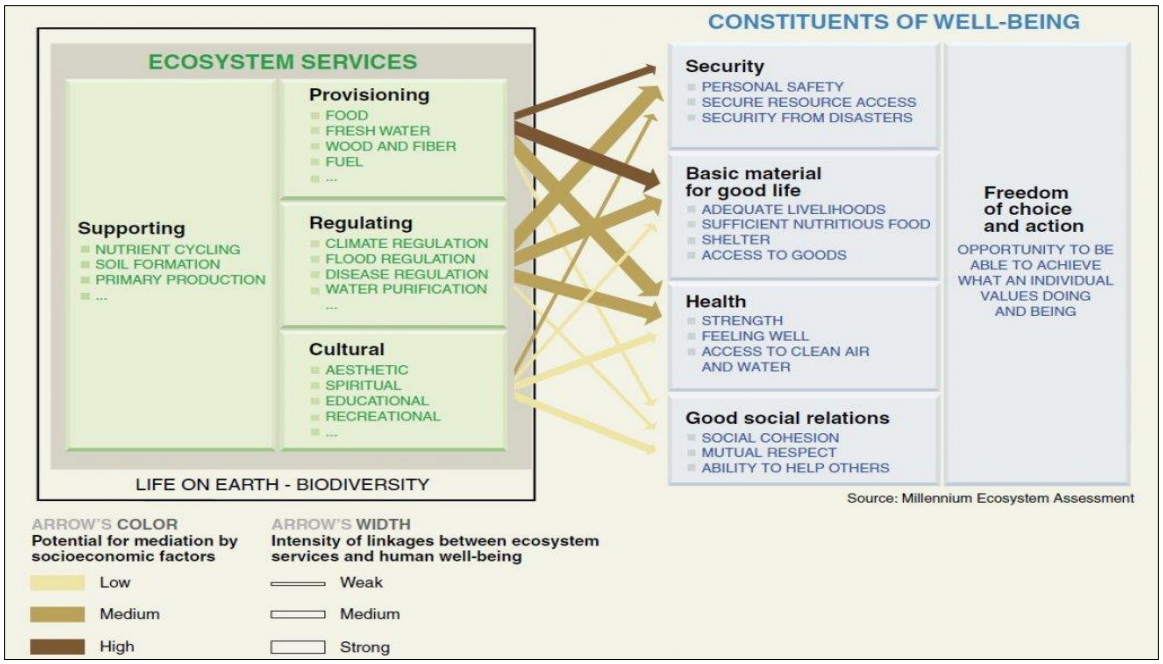
2.1.3 Synthesis

Before Erlich and Erlich, (1981), there had already been a growing interest in framing ecological concerns in economic terms to emphasize societal dependence on nature and raise public awareness of biodiversity conservation. Among these environment aware authors, Schumacher (1973) was probably the first to have used the term *Natural Capital.* Shortly after, other scholars began to refer to ecosystem (or ecological, environmental, nature) services, for example, Westman, (1977); Braat *et al*., (1979); Pimentel, (1980); *etc.* As reviewed by Braat and de Groot, (2012), the rationale behind this trend was to demonstrate how biodiversity deterioration affects ecosystem functions that support essential services to human well-being. Almost two decades after the first time the term was coined, the total value of the global ES was a milestone in the mainstreaming of the concept, resulting in a high impact in both science and policy making (Costanza *et al*., 1997).

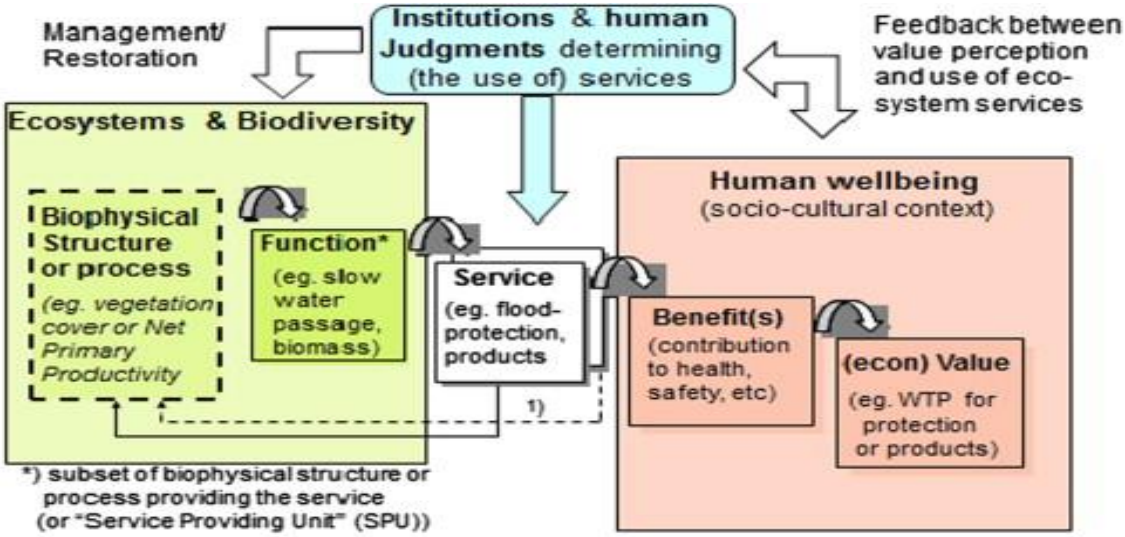
Authors from the 21st century have extensively used economic terms and cost-benefit approach for global environmental problems. Notable examples include Stern Review on the Economics of Climate Change (Stern, 2006); or the Cost of Policy Inaction (Braat and ten Brink, 2008). Following the upsurge of ES economic valuation studies, various market-based instruments, *e.g.* MES or PES, have been developed to meet the needs of policy makers in creating economic incentives for natural resources conservation. However, these instruments are criticized by only mimicking the real markets, given the limited amount of successful applications that could accommodate true criteria of market mechanisms.

Another noteworthy contribution is made by the MA, 2005, one of the most comprehensive study, up to date, that has portrayed the relevance of ecosystems to society as depicted in Fig. 2.1 A. Five years later, TEEB, another large-scale study was performed to support the economic explorations of ES associated studies (see Fig 2.1 B). Both studies were conducted under the United Nations Environmental Program (UNEP).

Within both models, the domain of Ecosphere (presented as services (MA) and processes, functions (TEEB)) is positioned on the left side, the Humanosphere (including different constituents of well-being (MA) and benefits, values (TEEB)) on the right side, and the ES flows are in the middle. The MA diagram stresses on the diversity of both the inputs from the ecological systems and their contributions to human society thus constitutes one of the most inclusive and widely used classification schemes of ES in the literature. The cascade model by TEEB, on the other hand, places ES between the natural and human systems and clearly separates benefits and values. As such, it shows more clearly that ES are delivered by the associated ecological structure and processes and that ES also bear specific functions within the associated systems, not only human benefits and values.



A. Diagram by MA. 2005



B. Diagram by TEEB. 2010

Fig. 2.1 The overview diagrams of Ecosystem Services

As such, only through the perceptions and interventions from the Humanosphere that ES can be recognized. Even a basic provisioning service, such as food delivery, requires labor, *e.g.* gathering, hunting, or harvesting. Likewise, cultural services involve neuron activities inside our brains to perceive, process and absorb. Regulating and Supporting services, however, are more

complex in this regard. In principal, ecosystems provide human society with livable environments (climate regulation), attenuate natural disaster impacts (flood protection), or facilitate human's activities (soil nutrients cycling), irrespective of human labor. In most of the cases, human interventions often negatively affect the sustainable provisioning of these services, hence reservation, restoration incentives are needed to mitigate the impacts and recover the capacity of these services. One shortcoming of the cascade model relates to the oversimplified transition from benefits to value that is in fact, a relatively complex process. Such transitions usually involve various variables and uncertainties, such as accessibility to the resources, relative scarcity of the resources, temporal and spatial scales, cultural background, *etc.* (Braat and de Groot, 2012).

2.2 Valuation of Ecosystem Services

The concept of ES is anthropogenic, and so is the valuation process of these services. Efforts of ES valuation (ESV), in particular, economic based approach, have been criticized for conserving ecosystems only for the sake of human. Liu *et al*., (2010) counterargues this statement in two aspects. First of all, rather than ends, ESV is only a means to communicate the concept of the difference between the two schools of thoughts concerning ecosystem conservation – for the benefit of man or the entire Earth. Also, the fact that ES have economic values does not necessarily lead to the sole focus of ESV on these benefits. Essentially, lumping the myriad of facets that human wellbeing depends on nature into a single economic indicator would be unrealistic.

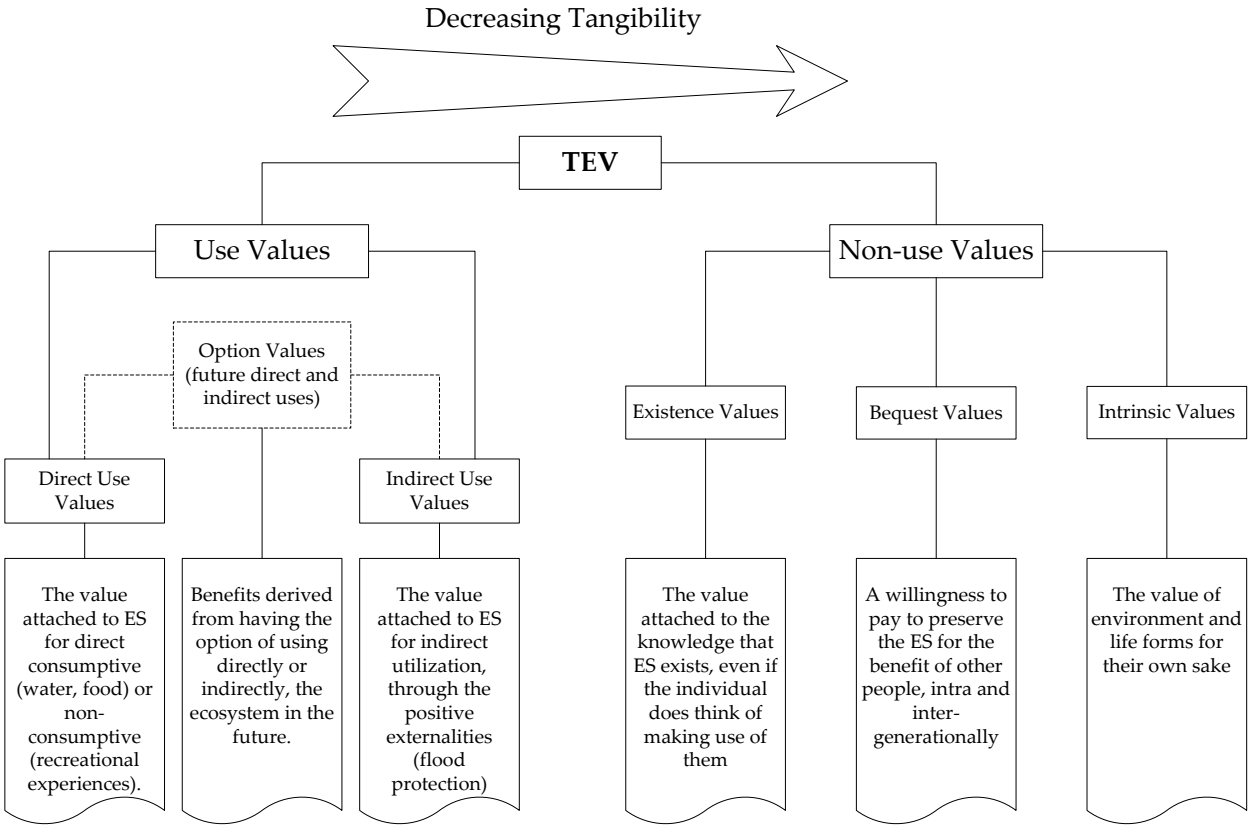
2.2.1 Economic Theory of value and Valuation Methods

While classical economists perceive the contribution of nature in relation to their use values, in neo-classical economics, the definition changed to exchange values (Gómez-Baggethun *et al*., 2010). In other words, the economic value is instrumental and arises from the subjective preferences of individuals.

Pragmatically, despite their importance, many benefits derived from nature are publicly shared, including neither rival nor excludable, so they are subject to market failure, in which market could not send the reliable price signals (Farley . 2008). Consequently, ES are often prone

to undervaluation and unsustainable use, and their benefits are commonly disregarded in decision-making processes. Hence, a range of non-market valuation techniques have been developed for ESV so that their contributions to the human economy, as well as the cost, emerging from their loss, could be explicitly expressed and compared to marketed goods and services (Costanza *et al*., 1997; TEEB, 2010).

One of the most important cornerstones of ESV studies is the total economic value (TEV), first introduced by Pearce (1993). The concept encompasses of all utility components of ES using money or any other market-based account unit as a common measurement. According to TEV, there is a range of economic value components as depicted in Fig. 2.2.



(Source: Turner et al., 2008)

Fig. 2.2 Components of Total Economic Value

The targets of economic ESV, however, only comprise of the left-hand side elements in the diagram, namely direct and indirect use values. Within the related literature, there is already a sustainable body of relevant review papers of economic techniques to estimate these values.

Notable publications, see for instance Turner *et al*., (2008); Liu *et al*., (2010), have thrived to provide systematical classifications of these economic techniques for ESV regarding applicability, validity, strengths, weaknesses, *etc*. Additionally, these methods have constantly evolved to address the current shortcomings, thus deliver more robust estimations of ES values to better support decision making (Atkinson *et al*., 2012; Loc *et al*., 2016). Table 2.1 briefly introduces some of the most widely used methods in estimating ES contributions to human well-being into economic terms, such as money.

Table 2.1 Economic Valuation Methods

1. Market Price Method (MP)	
Description	This method is used to value ES with well-established markets, for instance, food, timber, water.
Strengths	Can use readily available data on price. Robust
Weaknesses	Limited to cases with market data. Estimates are highly sensitive to functional form assumed for demand curve
Compatibility	Direct and indirect use values, suitable for lower bound estimate of TEV
2. Production Approach Method (PA)	
Description	This method estimates the contribution of ES to the production of commercially marketed goods.
Strengths	Data are often readily available, robust and conceptually straightforward
Weaknesses	Assessing the response of production to environmental changes may be difficult.
Compatibility	Indirect use value only, suitable for lower bound estimate of TEV
3. Hedonic Pricing Method (HP)	
Description	This approach used to estimate economic values associated with ES directly affecting market prices of other goods, *e.g.* housing prices.
Strengths	Data are often readily available, the method has strong theoretical background principles, and the expectations have been borne out by empirical studies.
Weaknesses	Requires data extensively, and expertise in econometric.
Compatibility	Direct and indirect use values
4. Travel Cost Method (TC)	
Description	This method estimates economic values associated with recreational sites or ecosystems through travel expenditures.

Strengths	Estimated values are revealed from actual behavior of individuals
Weaknesses	Cannot account for values that are imperceptible to short-term visitors
Compatibility	Direct and indirect use values, generally recreational benefits
5. Contingent Valuation Method (CVM)	
Description	This method is often used to estimate non-use values, and it is based on interviewing people to directly state their willingness to pay for specific ES, based on a hypothetical scenario.
Strengths	The only approach that is available up to date in accounting for non-use values.
	The method offers great flexibility to collect a large amount of information for analyses.
Weaknesses	Expensive to perform
Compatibility	Use and non-use values
6. Avoided Damage Cost, or Replacement Cost, or Substitute Cost Method (AC)	
Description	This method is based on costs of avoided damages that would result from the loss of ES, costs of replacing ES with human-made technologies, or costs of providing substitute services.
Strengths	Widely used because it is often easy to find estimates for costs
Weaknesses	Prone to under/overestimation
Compatibility	Not suitable for non-use values
7. Benefit Transfer Method	
Description	This method uses valuation results captured at one place and time (study site) to make inferences about the economic value of similar ES at another place and time (policy site).
Strengths	Quick and cheap alternative to original research
Weaknesses	Can deliver misleading results due to poor correlations between the study site and the policy site.
Compatibility	Use and non-use values

One of the fundamental distinctions among these economic methods of ESV is the data sources. In particular, the value can be derived from observing respondents' behaviors (revealed preference, such as market price); or responses to hypothetical questions (*i.e.*, stated preference, such as WTP, WTA), or based on actual costs: replacement or the avoidable cost. The Benefit Transfer Approach, however, does not fall into either of the categories according to this taxonomy. This special method has been applied as a "second best" approach in the case of a timely and

cost-effective measurement is required. The ability to transfer values from the study site to the policy site largely depends on the sites themselves and the services of interest. For instance, global scale regulating services such as carbon sequestration are easily transferable, in contrast to services perceivable at local scales such as flood protection or cultural significance. In Table 2.2, the author classifies the most appropriate valuation method for a range of popular ES as well as their transferability across different sites.

Table 2.2 Categories of ES and evaluation methods

Ecosystem Services	Appropriate Valuation method	Transferability	Monetization compatibility
Climate regulation	CV	High	Low
Disturbance regulation	AC	High	High
Water regulation	M, AC, RC, HP, P, CVM	Medium	High
Nutrient regulation	AC, CVM	Medium	Medium
Water provision	AC, M, TC	Medium	High
Food provision	M, P	Medium to High	High
Raw materials provision	M, P	High	High
Genetic resources	M, P	Low	Low
Medicinal resources	M, AC	High	High
Recreation	TC, AC, non-economic	Low	High
Aesthetics	H, CV, TC, non-economic	Low	High
Education	Non-economic	High	Low
Spiritual	CV, non-economic	Low	Low

Although economic ESV can provide useful information to make decisions in ecosystem management, the valuation techniques have critical limitations. First of all, monetary valuation can be challenging in accounting for complex ecosystems with the associated services that are overlapping and diversified in scales. For example, one might think of estimating the total economic values of a river from aggregating values of individual ES such as water provision, fish catch, hydrology regulation, *etc*. These services, however, are substantially irrelevant in ecological scale and largely overlapped, which eventually make the ultimate ESV result prone to double counting errors thus lacks robustness (Hein *et al*., 2006). This challenge is significant when ecosystems are in the vicinity of critical thresholds, where a small change can cause irreversible consequences, making monetary valuation inappropriate (Limburg *et al*., 2002). Should such

conditions be recognized, accounting for biophysical flows and quality become more relevant than monetization (Farley. 2008). Also, most cultural services as highlighted in the shaded rows of Table 2.1 are also, if not more appropriate to be analyzed through non-economic lenses. The methods associated with this approach that does not require valuation results expressed in a single monetary unit are further discussed in the following section.

2.2.2 None-economic Valuation approach

Economic methods are largely favored for ESV as this approach enables the comparison between conservation and development regarding economic benefits, which can be easily communicated to both experts and non-professional stakeholders. Nevertheless, the conversion of nature's full spectrum of benefits into a single monetary unit has been increasingly criticized, especially when applied to psychologically associated benefits. Ruckelshaus *et al*., (2013) observe that in many cases, stakeholders do not prefer attaching money to such services, in particular, the existence value of an iconic species or scared landscapes. Conceptually, considering the values of nature and the derived services for their sake is entirely consistent with the concept of ES (Reyers *et al*., 2012). Therefore, non-monetary valuation methods are necessary to fill the void left by economic valuation approach in ES studies. Adapted from the Report on Valuing the Protection of Ecological Systems and Services by the US EPA (Environmental Protection Agency), Table 2.3 introduces five common non-monetary approaches for ESV, namely Measures of attitudes, preferences, and intentions; Civic Valuation; Decision Science; Ecosystem benefit indicators; and Biophysical ranking.

Table 2.3 Non-economic valuation methods

Addressed values	Method	Outputs
1. Measures of attitudes, preferences, and intentions		
Attitudes and judgments, community-based values	Survey questions	Attitude scales, preference, and intention toward depicted environment or conditions
	Individual narratives and focus groups	Qualitative summaries and assessments from transcripts
	Behavioral observation	Inferences from observations of behavioral by individuals interacting with environments

2. Civic valuation		
Community-based values, indicator of economic value under some conditions	Referenda, and initiatives	Rankings of alternative opinions, or monetary or other measures of tradeoffs a community is willing to make, as a reflected in community choices
	Citizen valuation juries	Rankings of alternative opinions, or monetary or other measures of required payment or compensation, based on jury-determined assessments of public values
3. Decision science		
Constructed value	Decision science	Attribute weights that reflect tradeoffs individuals are willing to make across attributes, including ecological attributes, for use in assigning scores to alternative policy options
4. Ecosystem benefit indicators		
Indicators of economic value, and community-based values	Ecosystem benefit indicators	Quantitative spatially-differentiated metrics or maps related to supply or demand ES
5. Biophysical ranking methods		
Bio-ecological value	Conservation value	Spatially-differentiated index of conservation values across a landscape
	Ecological footprint	Area of an ecosystem (land and water) required to support a consumption pattern or population
Energy-based value	Embodied energy analysis	Cost of the total energy needed to produce an ecological or economic goods or services

(Source: EPA Science Advisory Board, 2009)

2.3 Spatial Distribution of Ecosystem Services Valuation

2.3.1 The Rationale

In addition to valuation, the representation of the ecological and human systems in geographical forms is essential to assess relevant ES. Especially, with the development of advanced GIS and earth observation technologies, ES mapping has emerged to an important research topic in recent years. Mapping of ES values means valuing ES across a relatively large geographical area and assessing how these values vary across space. Thereby, compared to site-specific ESV approach, results from ES mapping exercises can reveal additional valuable information. Besides enabling convenient visualization and communication of ES values on a

large spatial scale, ES mapping also allows for the extraction of estimated values at smaller scales and for any site of interest, to evaluate potential policy measures. These additional features are important in designing and implementing land use policies for sustaining the provision of ES (Schägner *et al*., 2013).

The rationale ES mapping strongly varies among studies. The noteworthy motivations include: evaluation of spatial congruence with biodiversity (Chan *et al*., 2006; Bai *et al*., 2011); analyzing synergies and trade-offs between different services (Chisholm, 2010; Häyhä *et al*., 2015); analyzing trends in ES (Harrison *et al*., 2010; Plieninger *et al*., 2013); estimating costs and benefits (Nelson *et al*., 2009); monetary valuation on biophysical quantities (Häyhä *et al*., 2015; Loc *et al*., 2016); or the prioritization of areas in spatial planning and management (Chan *et al*., 2006). The additional geographical dimension of *where* has the potential of improving the comprehensibility of ESV, thus better support land use decision making (Nahuelhual *et al*. 2015).

2.3.2 State of the Art

Recognizing the paramount importance of ES mapping, there has been a rapid increase of studies exploring the spatial distribution of ES across landscapes, utilizing a full range of approaches. Within the associated body of literature, review efforts have been made to describe the ES mapping state of the art, and highlight future research needs. One of such references can be made to Martínez-Harms, and Balvanera (2012), who suggested a broad classification of ES mapping methodologies consisting of three main camps: (1) Valuation of ES through benefit transfer, (2) Community value, and (3) Socio-ecological assessments of ES supply. Besides these three methods, another review paper by Maes *et al*., (2012) took not note on another simpler approach which derives information on ES directly from land-use/cover maps through proxies (Burkhard *et al*., 2009). This method has proved to be most appropriate to large-scale studies with confirmed correlations between ES and land uses, or in the case of limited data availability, and where the focus is on the presence of ES rather than on the supply quantification.

Fundamentally, there is no existing consensus in the literature on which approach is best to use for a specific reason or under specific circumstances. External factors that can be decisive in the choice of methodology are varied, including, for instance, data availability, relevant ES,

research area characteristics, the policy context, *etc.* External factors that can be decisive in the choice of methodology include, such as data availability, relevant ES, EDS, research area characteristics, or the political conditions. In yet another synthesis review effort, Schägner *et al*., (2013) thrive to typify the evaluated approaches, considering both ES mapping and value mapping methodologies. Thereby, the ES mapping methodologies can be either *Proxies, Non-validated models, Validated models, Representative data*; and *Implicit* modeling whereas the list of appropriate mapping methodologies for value includes *Unit values, Adjusted unit values, Value functions,* and *Meta-analytic value functions*. A tentative quality judgment on the advantages and disadvantages of these mapping approaches is also provided as reproduced in Table 2.4.

Table 2.4 Evaluation of mapping methods

ES mapping methods	Value mapping methods			
	Unit values	Adjusted unit values	Value functions	Meta-analytic value functions
Proxies	S	S	S	S
	LD	LD	MD	MD
	LP	LP	MP	MP
	UQ	UQ	UQ	TQ
Non-validated models	MC	MC	HC	HC
	MD	MD	MD	HD
	MP	MP	HP	HP
	UQ	UQ	UQ	TQ
Validated models	MC	MC	HC	HC
	MD	MD	HD	VHD
	MS	MS	HS	HS
	PQ	PQ	PK	KQ
Representative data	S	S	MC	MC
	HD	HD	HD	VHD
	MS	MS	HS	HS
	UQ	UQ	UQ	UQ
Implicit modeling	Not Applicable	Not Applicable	MC	MC
			MD	HD
			MS	MS
			UQ	PQ

Notes: *S, MD, HD: Simple, Medium complexity, High complexity; LD, MD, HD: Low, Medium, High data requirements; LP, MP, HP: Low, Medium, High precision; UQ, PQ, KQ, TQ: Unknown, Partly known, Known, Transparent quality; MS, HS: Medium, High spatial explicitness.*

(Source: EPA Science Advisory Board, 2009)

Not only are the methodologies diversified, but mapping studies also use a whole range of different indicators. Although the spatial exploration of ES commonly uses land use/cover, soils, vegetation, and nutrient related indicators, it is rarely possible to compare the results between

studies. This imbalance is because many studies use different primary indicators to map single service, or multiple, different indicators are employed in cases where single indicators are insufficient (Egoh *et al*. 2012). Other aspects of mapping services are also of great diversity. In particular, among different ES, global scale regulation services, *i.e.,* gas regulation, carbon sequestration are the most mapped given their high transferability (Table 2.2), followed by food and water provisioning services, and recreation services. In contrast, some particular supporting services, *e.g.* soil accumulation, pollination; or some site specific provisioning services, such as timber, biofuels are the least mapped. With respect to the data sources, land cover is the most predominant, irrespective of the types of addressed ES (Martínez-Harms and Balvanera. 2012).

Given the various challenges to deliver ES mapping results that are more accurate, precise, comprehensive, and more importantly, tailored for decision making, there is a need for a standard process. Built on two previous comprehensive reviews (Martínez-Harms and Balvanera. 2012, and Egoh *et al*. 2012), the work performed by Crossman *et al*., 2013 does aims at not only yet another review effort but also *a blueprint* that records standard attributes for mapping studies. In fact, the blueprint was crafted by several members of the ES-Partnership Thematic Working Group on Mapping ES, who convened a working group session at the 5th ESP Conference 2012 in Portland, Oregon USA, in the mission to provide a template and checklist of information needed for those carrying out mapping ES research. The long-term purpose is to constitute, over time, a database of completed blueprints that becomes valuable references of methods successfully utilized. Although it is widely acknowledged that studies are not likely to be heterogeneous given the diverse data availability and targets, efforts in standardizing the process such as the blueprint can reduce the uncertainty associated with ES quantification and valuation (Cook and Spray, 2012).

2.4 Prospects of the Concept

Prospect refers to the possibility or likelihood of some future event occurring (Oxford Advanced Learners' Dictionary). Within the following discussions, the use of prospect refers to the expectations of the scientific community for the ES concept; though widely discussed, remains poorly validated. In other words, various merits of the concept should be better described as

prospects or as Hauck *et al*., (2013) put it, promises rather than actual advantages. Within the scope of this chapter, the author addresses the use of ES knowledge (1) to redefine human-nature relationships, (2) to support decisions in different disciplines and (3) to constitute an integrated approach for policy planning practices. In the subsequent sections, these prospects and their implications are further elaborated

2.4.1 Connecting Society and Nature

Perhaps the most recent well-known promise was made by the Millennium Assessment (MA) in 2005 by introducing ES as a new conceptual tool to re-define the dependence of human societies on natural ecosystems. Accordingly, incorporating the ES concept into environmental analysis was believed to link conservation and human wellbeing more efficiently (Bremer *et al*., 2015). This benefit of using the ES concept was realized even earlier by Clark *et al*. (2003) who described the notion as the cornerstone of sustainability science for its focus on the interaction between nature and society.

However, the interconnectedness of humans and nature had been addressed well before these publications, in the West, for instance, under Judeo-Christian religion tenets and Greco-Roman philosophy dating to at least Plato (Callicot and Ames, 1989). In fact, knowing how we should position ourselves about nature had also been addressed in the relevant Catechism of both Western and Eastern religions, including Buddhism, Hinduism, and Islam, which provide moral guidance and have examined human-environment interactions (*e.g.* Dwivedi, 1993; James 2003; Abedi-Sarvestani and Shahvali, 2008). White's (1967) seminal and much-debated work suggested that Christian philosophy emphasizing humankind's dominion over nature was an important contributing factor to the environmental crisis. Similarly-themed ideas were expressed by renowned landscape architect Ian McHarg (1971) in his landmark book *Design with Nature*. Such discussions led others to more deeply explore the Eastern wisdom and religion emphasis on living in harmony with nature as a possible alternative to address ecological problems (Rolston, 1987; Callicot and Ames, 1989), although such translations are not straightforward and full discussion is well beyond the scope of this dissertation. Callicot and Ames (1989) provided a clear, thoughtful, and succinct summary of the philosophical debates related to ecological challenges,

noting that as an outgrowth of the turbulent 1960's, environmental philosophy became established in its right. Interestingly, in their mind, "Environmental philosophy…begins with the idea that traditional metaphysics and moral theory are more at the root of environmental problems than tools for their solution." So, the philosophical and ethical questions remain in debate; in other words, do we pursue intrinsic value philosophy as a guiding principle for development and are there alternative moral paths and philosophies to guide our ecosystem management decisions? The prospect of ES as a conceptual tool to position human society within the environment is not authentic in its normative form. However, the common origin of this prospect with many other philosophies could offer positive implications in discussing the relevant information to non-experts.

Within economy theory, Gómez-Baggethun *et al.*, (2010), trace the roots of human-environment relations to the 16th with the acknowledgment of land and labor as mother and father of value in the Pre-classical Economics. Thomas Robert Malthus, a clergyman and Professor of History and Political Economy at the East India Company College, examined the relationship between population, food production, and economy in his book *An Essay on the Principle of Population*, first published in 1798 (with six editions through 1826). In this work, he postulated that: 1) "food is necessary to the existence of man"; and 2) "the passion between the sexes is necessary and will remain nearly in its present state." Based on these postulates he then concluded: "Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio." and therefore: "By that law of our nature which makes food necessary to the life of man, the effects of these two unequal powers must be kept equal. This implies a strong and constantly operating check on population from the difficulty of subsistence. This difficulty must fall somewhere and must necessarily be severely felt by a large portion of mankind." The checks Malthus refers to are of two types, positive checks and preventative checks, the former which work to increase the death rate (*e.g.* disease and malnourishment) while the later decrease the birth rate (*e.g.* postponement of marriage and "moral restraint"). These checks are explored, as well, in terms of social and economic condition, for example, as Malthus argues that when the population (of laborers) increases faster than food production, inflation will increase (*e.g.* due to rising food costs) until the time that the checks reduce population, thereby

leading to higher real wages. These early ideas of carrying capacity and the relationship between humans and environment, of course, were rejoined in the late 1960's and early 1970's through works such as *The Population Bomb* and *The Limits to Growth* (Ehrlich, 1968; Meadows *et al*., 1972). The discussion of natural capital also was explored further through the emergence of Environmental Economics and Ecological Economics in the second half of the 20th century. These two specialized economic sub-disciplines were developed to complement the shortcomings of the standard economy in handling environmental problems with regard to the expansion of monetary valuation (Krutilla, 1967; Heal *et al*., 2005) and the substitutability of natural capital (Neumayer, 1999), respectively.

One of the central paradigms of the discipline of Geography is environment and society (Heffron and Downs, 2012; also see Skole, (2004) and this tradition, at least in the U.S., can be traced back to W.M. Davis in the late 1800's and apparently had early framing prior to that (Harden, 2012). Geography's exploration of human-environment interactions has evolved since the Davis' time, to include both the (now largely discredited) era of Environmental Determinism and post-Environmental Determinism (Judkins *et al*., 2008; Radcliffe *et al*., 2010; Harden, 2012). The eminent geographer and hydrologist, R.J. Chorley noted that "…the study of water provides a logical link between an understanding of physical and social environments." While water resource management has long been done at the watershed scale, more recently, the geographer, Swyngedouw (1999; 2009) explored the concept of "waterscapes" as a means to break down the so-called nature-social dualism. Perrault *et al*. (2012) succinctly explain a waterscape as a means to "…explore the ways in which flows of water, power, and capital converge to produce uneven socio-ecological arrangements over space and time, the particular characteristics of which reflect the power relations that shaped their production". Irvine *et al*., (2016) note that much of the work on advancing waterscape theory has been conducted by geographers, including the exploration of a related concept, the "hydro-social cycle" that borrows from the traditional hydrologic cycle framework, but places "…people and politics at the center of all water issues" (Linton, 2014).

In conclusion, ES might be thought of as a new interpretation of the classical human-nature relationship, which translates the recognized anthropogenic reliance on nature, either material or

non-material into comparable units such as money. Albeit perceived by many as the most significant advantage in decision making, the monetization of human benefits also is one of the most frequently criticized matters in applying the ES concept (McCauley 2006; Christie *et al*. 2012; Liu *et al*., 2010; Braat & de Groot. 2012; Beery *et al*., 2016).

2.4.2 Supporting Decisions in multiple disciplines

The multidisciplinary nature of ES studies is both a strength and a weakness of the ES concept. Pragmatically, the wide range of applications in different contexts has resulted from the broad definitions of ES yet the lack of structural relationships between elemental components: systems, functions, and services. The quantitative relationships among these elements are still poorly understood (Braat & de Groot. 2012); hence a common criticism of ES is that it is highly theoretical and impractical (Sitas *et al*., 2013). However, such characteristics can also constitute the attraction of ES as a flexible approach for various decision making contexts. In particular, the ES approach was initially developed to contribute a useful vehicle to assess the importance of natural resources to human society (MA, 2005; Daily *et al*., 2009; Portman, 2013) but its applications have recently expanded to the fields of policy guidance and priority setting (Guerry *et al*. 2015; Ruckelshaus *et al*. 2013; Beery et al. 2016); land use change assessment (Portman, 2013; Bateman *et al*., 2013); public awareness improvement (Beery *et al*., 2016) and urban green space design (Rall *et al*., 2015). It is worth noting that soon after the modern idea of "sustainable development" was formalized in 1987 under the World Commission on Environment and Development's *Our Common Future*, some of the criticisms leveled were that the concept was too vague to be of practical use, meaning all things to all people (and to the extreme promotes "cosmetic environmentalism" or "fake greenery"); it focused too much on economic development; that it potentially fostered delusions whereby development can happen sustainably without constraints or limits to growth; and that strong sustainability was "morally repugnant" while weak sustainability offered nothing new (*e.g.* Beckerman, 1994; Robinson, 2004). Yet, here we are 30 years later, still using sustainable development as a guiding principle and refining our methodologies to determine whether a particular project or society is following a sustainable path. It can be argued that ES assessment

is one of many tools in the sustainability arsenal and that if it truly is a valuable analytical approach, it will continue to evolve, be refined, and sharpened.

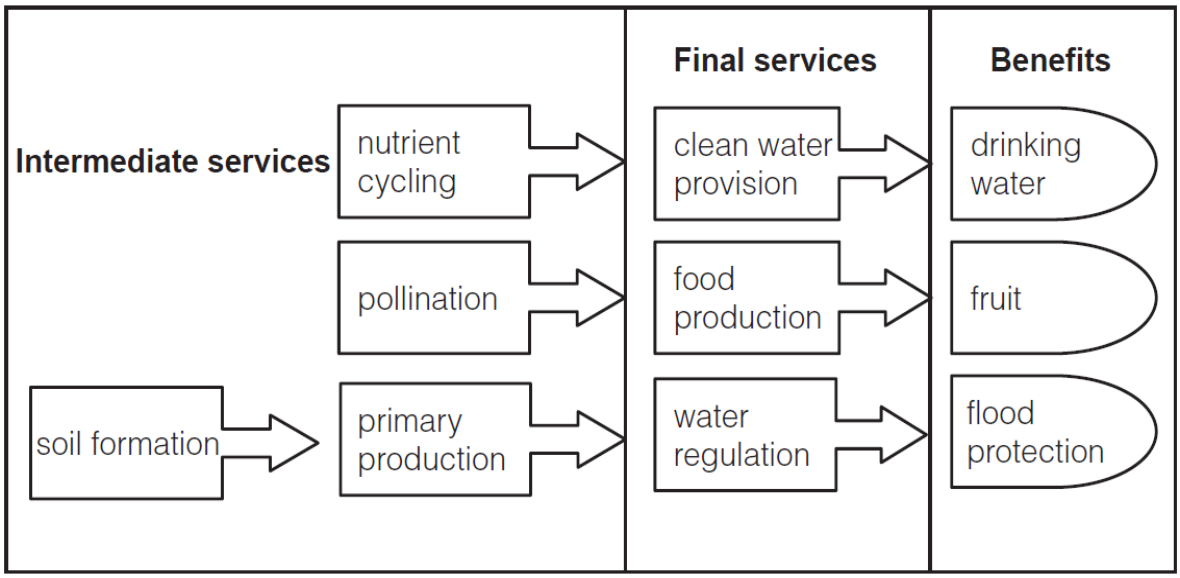
Many more applications are expected to be realized as researchers from multiple disciplines adopt the concept for their research. The question "should we worry about or applaud the emerging multifunctional characteristic of the ES concept?" has been considered by various groups. Pessimists may be concerned that as more scientific disciplines become involved, the ES concept will become multiform and harder to grasp (Boyd & Banzhaf 2007; Gómez-Baggethun *et al.,* 2010). For optimists, however, diversity is in principal healthy as it leads to exploration, experimentation, and refinement of theory which ultimately can establish the paths of greatest utility.

To sum up, it is important for ES practitioners, regardless of their original background and intended applications, to strictly respect the concept fundamentals, *i.e.,* the facilitation of social appreciation for ecosystems even with the current absence of standardized definitions and practical guidelines (Seppelt *et al.,* 2011; Scarlett & Boyd 2013; Häyhä and Franzese 2014; Seifert-Dähnn *et al.,* 2015).

2.4.3 An Integrated Approach for Decision-making

The ES approach essentially provides a comprehensive and holistic approach for decision making, which puts great emphasis on the flow of human benefits derived from our living environment (Greenhalgh & Hart 2015; Pittock *et al.,* 2012; Hansen *et al.,* 2015). Accordingly, the concept helps to elucidate the links between human well-being and the state of ecosystems, as well as facilitating communication of economic and non-economic values and their integration into accounting and reporting systems (Jennifer Hauck et al., 2013). Compared to other approaches, the ES-based frameworks present a complete, holistic and integrated consideration of the socio-ecological system. Turner *et al.,* 2008 contributed a very precise and concise visualization of ES framework in these regards, as reproduced in Fig. 2.3. It is noteworthy that the emergence of ES framework, serving multiple purposes contributes a significant body within the literature, which the author also thrived to address explicitly within Chapter 5 of this dissertation.

In the same manner, the concept is considered as an effective framing of the environmental issues regarding communicating with and influencing stakeholders and decision makers (Mascarenhas *et al.*, 2015). More specifically, the inclusion of an anthropocentric lens is useful to facilitate the arguments of conservation from both moral and utility standpoints (Beery *et al.*, 2016; Lamarque *et al.*, 2011). Therefore, mainstreaming the concept into decision making is expected to render important contributions towards more equitable and sustainable development (Sitas *et al.*, 2013). With these benefits, the concept could be of particular attractive to policy makers (Albert *et al.*, 2016) and can evolve to become the key driver in policy fields, re-shaping existing and emerging environmental policies in the coming decades (Partidário 2010; Geneletti 2012; Baker *et al.*, 2013; Matzdorf & Meyer 2014).



(Source: Turner et al., 2008)

Fig. 2.3 The Ecosystem Services Framework

During the article search, it was comparatively easier to identify discussions on the prospects of ES. In the same manner of this chapter, this information is commonly cited in the Introduction part of the manuscripts which traditionally refers to previous publications, especially iconic articles (Costanza *et al.*, 1997; MA. 2005; or TEEB. 2010) to justify the motivation behind choosing the respective approaches. The (re)citations of these prospects and promises from time to time might gradually accrue to blurring the boundary between what is to be expected and what has been fully proven as applicable. For instance, "ES will change policy and halt the loss of

biodiversity" are rather expectations than proven usages, at least in the near future (Laurans *et al.*, 2013; Mascarenhas *et al.*, 2015). This statement is, by no means, to question the validity and contributions of these prospects. As a matter of fact, the author absolutely believe that these visions have crucial roles in shaping research directions to supplement knowledge gaps. Therefore, practitioners are required to rigorously identify objectives based on sound theoretical foundations and verified relevance to specific decision contexts to realize these prospects and promises.

2.5 Modern Caveats

There is a growing body of literature addressing the shortcomings of the ES concept on its theoretical weaknesses (*e.g.* McCauley 2006; Ghazoul 2007; Schröter *et al.* 2014; or Seifert-Dähnn *et al.*, 2015) and practical barriers confronting the practitioners in the field. Alongside these criticisms include findings from stakeholder interviews (Sitas *et al*., 2013; Beery *et al*., 2016) and evaluation of relevant policies (Verburg *et al.,* 2016; Pittock *et al.,* 2012; Greenhalgh & Hart 2015; Schleyer *et al*., 2015). However, the systemization of the knowledge mentioned above is critically challenged, firstly by the diversity of author's academic backgrounds (*e.g.* disciplines, viewpoints), and the research area contexts (*e.g.* levels of economic development and environment concerns). In line with the overall attempt of this dissertation to portray the current profile of ES, and at the same time make it practical for interdisciplinary teams and practitioners, the author undertook efforts to take notes on concurring caveats regarding a categorized presentation of important findings. In the following sections, the author has identified challenges in mainstreaming the ES concept in policy planning and decision making with regard to (1) Theoretical critiques, (2) Survey-based observations, (3) Appraisals of Political conditions, and (4) Multidisciplinary barriers. Despite being clearly categorized, discussions do converge at times given that, to consolidate the methods, application methodologies often acknowledge theoretical analysis which is interchangeably updated by real-world applications.

2.5.1 Theoretical Critiques

The majority of inputs for this section were developed from McCauley (2006) and Schröter *et al.,* (2014), two commonly cited papers that address the current challenges of the ES approach. Schröter *et al*., (2014) synthesized and described seven important criticisms and their counter-arguments regarding (1) the environmental ethics related to the anthropogenic focus and exclusion of the intrinsic value (McCauley, 2006), (2) the economic metaphor of human-nature relationships which could encourage natural resources exploitation (Raymond *et al*., 2013), (3) conflicts with concepts of biodiversity (McCauley 2006; Ridder 2008), (4) the controversies of economic valuation, such as the identification of what should be included within the market sphere, or the masked ecological complexity by commodification (McCauley 2006; Gomez-Baggethun & Ruiz-Perez 2011), (5) commodification and Payment for ES (PES) (Turnhout *et al*., 2013), (6) the vagueness associated with core terminologies (Nahlik *et al.*, 2012), and finally (7) the optimistic assumptions and normative aims (McCauley 2006).

Apart from the comprehensive synthesis by Schröter *et al.* (2014), there is a relatively sparse number of theoretical critiques about ES in the literature, despite the relative importance and contestation regarding ES. The majority of these arguments, to some extent are encapsulated by Schröter's criticisms. For instance, Ghazoul (2007) highlighted the risk of overemphasizing the role of single services, especially provisioning services that are essentially in line with Schröter's *biodiversity critique.* Likewise, Wainger and Mazzotta (2011)'s concern about the conflicting definitions in ES or Burkhard, Petrosillo, & Costanza (2010)'s argument about the lack of practical applications, both resonate deeply with the *vagueness critique*. Also in this regard, the *economic valuation critique* is widely shared by other researchers (see for instance Christie *et al*., 2012, Liu *et al.,* 2010, Braat and de Groot. 2012, and Beery *et al.*, 2016). What Schröter *et al*., (2014) might have failed to address is the redundancies of ES with other approaches (Pittock *et al.,* 2012, Böck *et al.,* 2015). This critique substantially emerges from the common origin which the ES concept shares with many other philosophies (see Section 3.1). Pragmatically, some would argue that what decision makers need for their jobs can be largely met by the existing environmental management plan framework, hence the hesitancy towards the additional workload to utilize ES information.

The poor translation of research outcomes into useful information to decision makers (Chan *et al.* 2006) and the temporal pace mismatches between scientific knowledge development and decision makers' demand for such information (Portman, 2013) were also revealed as critical barriers to the integration of ES in the existing policy frameworks.

2.5.2 Survey-based Observations

In social sciences, survey methods such as questionnaires, face to face interviews, *etc*. are widely applied for primary data collection. In ES research, these methods are also utilized to explore the applicability and validity of the concept from stakeholders' perspectives. For this discussion, the author investigated findings from Beery *et al.* (2016) who interviewed 36 Swedish municipal stakeholders; Sitas *et al.* (2013) who involved approximately 200 stakeholders from various sectors at Eden District, South Africa and Marre *et al.* (2015)'s online survey which was completed with 88 respondents in Australia. In particular, participants in Beery *et al.,* (2016) perceived the ES concept as "too broad" or "freely interpretable" with a lack of clear definitions and believed that without previous knowledge, the ES assessment would be difficult to grasp. Others added by describing the concept as theoretical and essentially separate from reality. In the same manner yet more specific, Sitas *et al.*, (2013) reported that the causes of respondents' confusion included the relationship between biodiversity and ES, valuation methods, assumption that ES originate only from pristine ecosystems, the question whether ES are only the end benefits, and the misinterpretation of ES to publicly provided services. Finally, the nation-wide survey of Marre *et al.*, (2015) examining the reasons why ES valuation had not been used in decision making included the lack of robustness, accessibility and relevant framework/guideline on ES information which resulted in limited political impacts. In principal, regardless of research areas and survey methods, respondents in all three case studies essentially struggled in grasping the idea of ES, which largely agrees with the theoretical critique regarding the concept vagueness addressed in the previous section (McCauley 2006; Seppelt *et al.,* 2011; Scarlett & Boyd 2013; Schröter *et al.,* 2014; Seifert-Dähnn *et al.,* 2015).

Besides the general agreement mentioned above, other differences in survey observations amongst countries also confirmed the relevance of economic development and environmental

concerns with respect to the problems confronting the integration of ES in policy planning processes. More specifically, the application of ES in developed countries with a long history of environmental considerations, for instance, Australia and New Zealand need to clearly highlight the added values of ES to justify the additional workload to integrate such information given the already complex management plans (Pittock *et al.,* 2012; Greenhalgh & Hart 2015). Conversely, for developing countries with limited resources allocated for the environment, what constitute the challenges include the disjointed operating conditions with limited collaboration between institutions, weakly aligned policies, and minimal proactive planning (Sitas *et al.,* 2013). In the same manner, Daily *et al.,* (2009) concluded that fostering the ES approach can be much more complicated for societies that either do not value nature or are obsessed by short-term economic growth.

Regional differences may be reflected in the exploration of economic values of non-marketed ES using deliberative approaches such as contingent valuation methods (CVM) during social surveys and questionnaires. For instance, CVM studies in developing countries predominantly rely on in-person interviews supported by local facilitators due to a low response rate of self-administered methods such as emails, on-line surveys, and telephone contacts, as are conventionally applied in developed countries. Besides, these studies are often prone to bias due to the lack of useful listings of the population from which the sample must be drawn and the lesser likelihood of pre-discussions (and piloting) amongst the communities prior to the interviews. Other difficulties in conducting CVM in developing countries emerged from respondents' struggle to grasp the important terminologies such as theoretical scenarios, willingness to pay (WTP) or willingness to accept (WTA), unlike the counterparts from developed world , who are more accustomed to these terms (Whittington *et al.*, 1990). To illustrate this issue, using a relatively plausible example, Loomis *et al.,* 2000 conducted a very nice and rigorous study using the CVM approach to assess the economic value of restoring ES in an impaired section of the Platte River, Colorado. Based on four identified key ES (dilution of wastewater, natural purification of water; erosion control; and habitat for fish and wildlife), a survey of nearly 100 people indicated that households would pay an average of $21 per month or $252 annually for the additional benefits from ES. Based on our experience in conducting surveys in rural areas of

Southeast Asia, it is unlikely that these households would understand the concept of paying for these types of services. In addition, the literal translation of certain words and concepts into another language can present confusion and barriers to successful implementation of surveys. In assessing the application of Integrated Water Resource Management (IWRM), Community Based Natural Resources Management, and participatory planning in rural Cambodia, for example, Irvine *et al.,* (2010) noted that local communities may have very different terms for the type of forest to be managed (spirit forest, burial forest, watershed forest, and multiple use forest) as compared to the technical definitions used by government agencies. Against all the odds, deliberative approaches are largely believed to be more easily administered in developing countries than in industrialized ones owing to the typically higher response rates, better reception of questions and cheaper facilitators (interviewers). Given the limited available data from other sources, the marginal benefits of additional revealed information from deliberative surveys is likely to be comparatively greater in developing countries (Whittington, 1998).

2.5.3 Appraisals of Political Conditions

In this section the author explores institutional barriers in applying the ES concept through the appraisal of political contexts. In the analysis, the author incorporates findings from studies of regional, national and continental scale. Verburg *et al.*, (2016) applied an analytical framing method to evaluate regional and national policy documents in the United Kingdom, Belgium and the Netherlands. Identified challenges were the need for tailored objectives, usable language of participation, empty signifier or boundary arrangement, and the governance of involvement and the controversies of a market approach. More specifically, the careful development of objectives could accommodate the intended changes in policies emerged from the integration of nature values with economic activities (de Groot *et al.,* 2002); the common language amongst participants is essential for effective collaborative actions. The treatment of ES as an empty signifier (or as defined by Schleyer *et al.,* (2015), a boundary concept that refers to the same object, phenomenon while carries different meanings according to different disciplines) can save the energy normally put in educating stakeholders about formulated "accurate" descriptions, hence attracts interests and convicts of stakeholders. Even with the collaboration willingness of communities, the

governments' durable commitments in terms of information, advice, resources and support are crucial to achieve the integration of ES into practice. The challenge is governments, in general, aim for short term achievements, hence leading to distrust, conflicts, limited legitimacy, and dissatisfaction amongst participants. The case studies by Verburg *et al.*, (2016) also highlighted the controversies between the preferred use of market methods to evaluate ES by the environmental agencies and the skeptical behaviors of many participants, which ultimately makes the process even more complicated. For instance, the mainstream of governmental subsidies to facilitate PES initiatives might make one wonder about the added values of ES approach.

Likewise, Pittock *et al.,* (2012) revealed issues associated with Australia's bureaucracies including the lack of effective frameworks to consider human-environment interactions that have hampered the achievement of environmental strategies. Similarly, "challenges encountered along the pathway" in the New Zealand context are reflected by the absence of knowledge or data availability, appropriate assessment indicators to convey ES information, language to describe and communicate ES information, terminology differences between ES and related existing policies (Greenhalgh and Hart, 2015). Finally, contributions by Schleyer *et al.,* (2015) refer to the continental scale in addressing the challenges of Europe. What had been described as obstacles comprise of language barriers to accommodate effective discussions, the lack of regulatory frameworks, the dominance of simple economic benchmarks such as GDP, hesitancy of other policy fields towards implementing environmental issues into non-environmental policies and finally, a variety of interpretations for "mainstreaming" ranging from simple uptake of the terms into existing policies to comprehensive and obligatory incorporation and application. The integration of ES information in policies within the explored studies is constantly challenged by the absence of regulatory frameworks across the explored studies. These findings also resonate with Seifert-Dähnn *et al.,* (2015) with regards to the urgent need for definition standardization and practical guidelines in facilitating more reliable implementation of ES theory. Indeed, there is an extensive body of work by notable scholars such as Turner et al (2008) that suggest policy relevance is still obscurely demonstrated in ES evaluation studies that result in limited political utility in the outcome.

2.5.4 Multidisciplinary barriers

In the general efforts to adequately position human society in relation to nature using the ES concept, it is widely accepted that relying solely on either of technical arguments or social-based analysis would be critically insufficient (Mann *et al.,* 2015). Instead, an appropriate approach requires both a multidisciplinary and transdisciplinary approach (Max-Neef., 2005). Unfortunately, as Margles *et al.,* (2010) noted, "Cases of practitioners and researchers from different disciplines successfully working in concert towards an integrated conservation approach are rare." Why is this so? How do we turn barriers into bridges?

Even within an institutional setting that is expected to be innovative, the barriers to multidisciplinary can be observed. Most universities traditionally are arranged by the school (or faculty) and departments, and this silo-type organization does little to promote the multidisciplinary interactions required of ES analysis. Sure, universities have established multidisciplinary research institutes that focus on solving complex environmental problems, but Crow (2010) notes two important shortcomings in the system: (1) the discipline-based departmental structure that we now take for granted; and (2) we attach less prestige to collaborative endeavors that target real-world problems, and to team participation in projects that accomplish assessment, assimilation, synthesis, implementation, and application. Underscoring Crow's second point, Gibson (2012) notes "Despite this progress, the civic engagement movement has miles to go before genuinely democratic, engaged, and civic colleges and universities characterize all of American higher education." In a National Science Foundation-funded study of interdisciplinary research centers and programs in the U.S. Rhoton (2004) concluded "many initiatives deemed interdisciplinary are, in fact, merely reconfigurations of old studies—traditional modes of work patched together under a new label…" and that while both monetary and human resources had been provided to establish interdisciplinary work, as a norm, in fact far less has been accomplished than should have been.

The gameplay of ES should at least involve the knowledge of ecologists and economists to be operational (Braat & de Groot 2012). To support decision-making processes, the analytical framework should also incorporate social and institutional dimensions. The inclusion of

stakeholders and civil society players is needed to design and implement institutions and strategies that work on the ground. Many authors have highlighted the need to strengthen the social dimension of ES frameworks to better understand the characteristics, interests, roles and responsibilities of relevant players (Mann *et al.*, (2015), Schröter *et al.*, (2015), and Schleyer *et al.*, (2015). The possible stakeholders involved with an ES analysis is summarized in Figure 2.5, in which, the overlapping of circles implies the equal partnership and contributions amongst the four parties, on the one hand. The appreciation of Nature using ES, on the other hand, could potentially constitute a platform on which different world views can communicate and collaborate (Schröter *et al.*, 2014)

Within the overall ES interplay, the additions of institutional and social dimensions is crucial to sensitively account for vertical policy scale (national, regional or local) and the horizontal profile of ES acknowledgments across distinct sectors *e.g.*, environment management, agriculture development and spatial planning (Schleyer *et al.*, 2015). Of course, the more players involved, the more challenging the administration becomes.

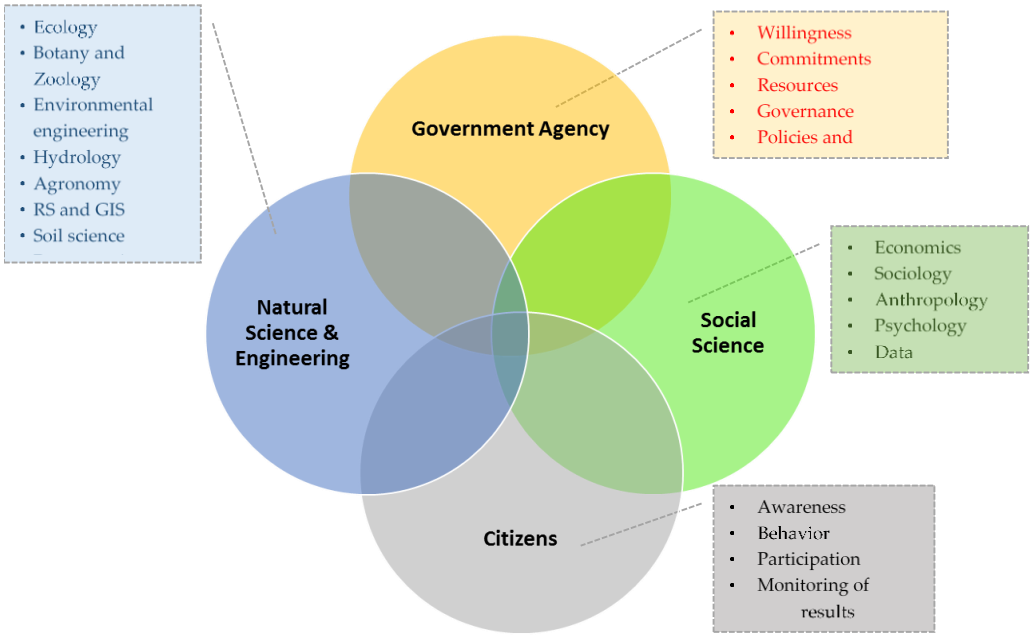


Fig. 2.4 Summary of potential disciplinary expertise required in ES evaluations

Firstly, experts from different study fields use different disciplinary lenses, languages, and terminologies to view the same problem. Just as translation between the languages of two different countries, or two distinct stakeholders from civil society can create challenges to ES studies, so do different "expert languages" create challenges. These language differences may produce, for instance, difficulties with the translation of ecological changes to outcomes appropriate for economic analyses. Besides, the poor transcription of research outcomes into meaningful information for stakeholders and available inputs to decision makers (Chan *et al.*, 2006), the temporal pace mismatches between scientific knowledge development and decision makers' demand for such information (Portman, 2013) is also noteworthy amongst emerging barriers. Moreover, institutional barriers at multiple scales ranging from the individual level (lack of resources and capacity) to the organizational level (inaccessibility to appropriate information) and the general national level (weakly aligned policies and legislations) also substantially contribute to the limited integration of ES studies in mainstream planning.

With regard to bridging these gaps, Wainger & Mazzotta. (2011) proposed a translational ecology modeling framework to link a factor influenced by policies to a change in an ecosystem stressor, which are subsequently associated with quantifiable outcome matters to stakeholders. With a similar perspective, Cowling *et al.*, 2008 emphasized the importance of stakeholder involvement at various stages of a study, including assessment, implementation, and management to improve relevance, credibility and applicability of ES research outcomes. Stakeholders may include government agencies, the private sector, and civil society (usually in the form of not-for-profit groups or Non-government Organizations (NGOs)). Policy relevance and stakeholder involvement have been increasingly recognized as inseparable characteristics for operational ES frameworks (Nahlik *et al.*, 2012), and yet here we also see challenges. Some of these difficulties are associated with technology transfer from universities to the other stakeholders For example, Irvine *et al.* (2015) reviewed the issue of modeling practices in an Integrated Water Resources Management framework and noted problems of the inability or resistance of many stakeholders in government agencies and NGOs to embrace and adopt modeling tools. Development of user-friendly Decision Support Systems that integrate, simplify, and help

interpret model output regarding decision-making might facilitate greater adaptation of modeling approaches for ES studies.

References

Abedi-Sarvestani, A. and Shahvali, M. 2008. Environmental ethics: toward an Islamic perspective. *American-Eurasian Journal of Agricultural and Environmental Science*. 3(4), pp. 609-617.

Albert, C., Bonn, A., Burkhard, B., Daube, S., Dietrich, K., Engels, B., Frommer, J., Götzl, M., Grêt-Regamey, A., Job-Hoben, B., Koellner, T., Marzelli, S., Moning, C., Müller, F., Rabe, S.E., Ring, I., Schwaiger, E., Schweppe-Kraft, B. and Wüstemann, H., 2016. Towards a national set of ecosystem service indicators: Insights from Germany. *Ecological Indicators.* 61, pp. 38–48.

Andréassian, V., 2004. Waters and forests: from historical controversy to scientific debate. *Journal of Hydrology,* 291, pp. 1–27

Atkinson, G., Bateman, I. and Mourato, S., 2012. Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review Econonomic Policy* 28, pp. 22–47.

Bai, Y., Zhuang, C., Ouyang, Z., Zheng, H. and Jiang, B., 2011. Spatial characteristics between biodiversity and ecosystem services in a human-dominated watershed. *Ecological Complexity* 8, pp. 177–183

Baker, J., Sheate, W.R., Phillips, P. and Eales, R., 2013. Ecosystem services in environmental assessment - Help or hindrance? *Environmental Impact Assessment Review*, 40(1), pp. 3–13.

Bateman, I.J., Harwood, A.R., Mace, G.M., Watson, R.T., Abson, D.J., Andrews, B., Binner, A., Crowe, A., Day, B.H., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., Hulme, M., Kontoleon, A., Lovett, A. a, Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G., van Soest, D. and Termansen, M., 2013. Bringing ecosystem services into economic decision-making: land use in the United Kingdom. *Science* 341, pp. 45–50.

Bayon, R., 2004. Making Environmental markets work: lessons from early experience with sulfur, carbon, wetlands, and other related markets. Forest Trends, Katoomba Group Meeting in Locarno, Switzerland, 2003

Beckerman, W. 1994. 'Sustainable development': Is it a useful concept? *Environmental Values*, 3(3), pp. 191-209.

Beery, T., Stålhammar, S., Jönsson, K.I., Wamsler, C., Bramryd, T., Brink, E., Ekelund, N., Johansson, M., Palo, T. and Schubert, P., 2016. Perceptions of the ecosystem services concept: Opportunities and challenges in the Swedish municipal context. *Ecosystem Services*. 17, pp. 123–130.

Böck, K., Muhar, S., Muhar, A. and Polt, R., 2015. The ecosystem services concept: Gaps between science and practice in river landscape management. *Gaia*, 24(1), pp. 32–40.

Boyd, J. and Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, 63(2-3), pp. 616–626.

Braat, L.C. and de Groot, R., 2012. The ecosystem services agenda:bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosystem Services*, 1(1), pp. 4–15.

Braat, L.C. and Brink,P. ten, (Eds.), 2008. The Cost of Policy Inaction: the Case of not Meeting the 2010 Biodiversity Target. Report to the European Commission Under Contract: ENV.G.1./ETU/2007/0044, Wageningen, Brussels, Alterra Report 1718

Braat, L.C., van der Ploeg, S.W.F. and Bouma, F., 1979. Functions of the Natural Environment Institute for Environmental Studies. Free University, Amsterdam. (Publ. 79/9).

Bremer, L.L., Delevaux, J.M.S., Leary, J.J.K., Cox, L.K. and Oleson, K.L.L., 2015. Opportunities and Strategies to Incorporate Ecosystem Services Knowledge and Decision Support Tools into Planning and Decision Making in Hawai'i. *Environmental Management*, 55(4), pp.884–899.

Burkhard, B., Kandziora, M., Hou, Y. and Müller, F., 2014. Ecosystem service potentials, flows and demands-concepts for spatial localisation, indication and quantification. *Landscape Online*, 34(1), pp. 1–32.

Burkhard, B., Kroll, F., M¨uller, F. and Windhorst, W., 2009. Landscapes' capacity to provide ecosystem services: a concept for land cover based assessments. *Landscape online* 15, pp. 1–22

Burkhard, B., Petrosillo, I. and Costanza, R., 2010. Ecosystem services - Bridging ecology, economy and social sciences. *Ecological Complexity*, 7(3), pp. 257–259.

Callicot, J. and Ames, R.T., 1989. Introduction: the Asian traditions as a conceptual resource for environmental philosophy. In: Nature in Asian Traditions and Thought: Essays in Environmental Philosophy. State University of New York Press, Albany.

Chan, K.M.A., Shaw, M.R., Cameron, D.R., Underwood, E.C. and Daily, G.C., 2006. Conservation planning for ecosystem services. *PLoS Biology* 4, pp. 2138–2152.

Chisholm, R.A., 2010. Trade-offs between ecosystem services: water and carbon in a biodiversity hotspot. Ecological Economics 69, pp. 1973–1987

Chorley, R.J. 1971. Introduction to physical hydrology. London: Methuen and Co Ltd.Swyngedouw E. 2009. The political economy and political ecology of the hydro-social cycle. *Journal of Contemporary Water Research & Education*. 142, pp. 56-60.

Christie, M., Fazey, I., Cooper, R., Hyde, R. and Kenter, J.O., 2012. An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. *Ecological Economics*, 83, pp. 67–78.

Clark, W.C. and Dickson, N.M., 2003. Sustainability science: the emerging research program. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14), pp. 8086–8091.

Clawson, M., 1959. Methods for measuring the demand for and value of outdoor recreation. Resources for the future, Washington D.C

Cook, B.R., Spray, C.J., 2012. Ecosystem services and integrated water resource management: Different paths to the same end? *Journal of Environmental Management* 109, pp. 93–100

Costanza, R. (Ed.), 1991. Ecological Economics: the Science and Management of Sustainability. Columbia University Press, New York

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S. and Turner, R.K., 2014. Changes in the global value of ecosystem services. *Global Environmental Change*. 26, pp. 152–158.

Costanza, R., 2008. Letter to the Editor Ecosystem services : Multiple classification systems are needed. *Biological Conservation*, 141(2008), pp. 350–352.

Costanza, R., Daly, H., 1992. Natural capital and sustainable development. *Conservation Biology* 6, pp. 37–46

Costanza, R., Arge, R., Groot, R. De, Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V, Paruelo, J., Raskin, R.G., Suttonkk, P. and van den Belt, M., 1997. The value of the world ' s ecosystem services and natural capital. *Nature* 387, pp. 253–260.

Cowling, R.M., Egoh, B., Knight, A.T., O'Farrell, P.J., Reyers, B., Rouget, M., Roux, D.J., Welz, A., Wilhelm-Rechman, A., 2008. An operational model for mainstreaming ecosystem services for implementation. *Proceedings of the National Academy of Science of the U. S. A*. 105 (28), pp. 9483–9488.

Crocker, T.D., 1999. A short history of environmental and resource economics. In: van der Bergh, J. (Ed.), Handbook of environmental and resource economics. Edward Elgar, Northampton, Massachusetts.

Crossman, N.D., Burkhard, B., Nedkov, S., Willemen, L., Petz, K., Palomo, I. et al., 2013. A blueprint for mapping and modelling ecosystem services. Ecosystem Services. 4, pp. 4–14.

Crow, M.M. 2010. Organizing teaching and research to address the grand challenges of sustainable development. *BioScienc*e, 60(7), pp. 488-489.

Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: Time to deliver *Frontiers in Ecology and the Environment*,. 7, pp. 21–28

Daily, G.C., 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, DC

Daly, H.E., 1977. Steady State Economics. W.H. Freeman, San Francisco

de Groot, R.S. , Alkemade, R., Braat, L., Hein, L. and Willemen, L., 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity*, 7(3), pp. 260–272.

De Groot, R.S., 1987. Environmental functions as a unifying concept for ecology and economics. *The Environmentalist* 7 (2), pp. 105–109

de Groot, R.S., Wilson, M.A. and Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, 41(3), pp. 393–408.

Dwivedi, O.P. 1993. Human responsibility and the environment: A Hindu perspective. *Journal of Hindu-Christian Studies*, 6, pp. 19-26.

Egoh, B., Drakou, E.G., Dunbar, M.B., Maes, J. and Willemen, L., 2012. Indicators for mapping ecosystem services: a review. Report EUR 25456 EN. Publications Office of the European Union, Luxembourg.

Ehrlich, P.R. 1968. The Population Bomb. Ballantine Books, New York.

Ehrlich, P.R., Ehrlich, A.H., 1981. Extinction: the causes and consequences of the disappearance of species. Random House, New York

EPA Science Advisory Board, 2009. Valuing the Protection of Ecological Systems and Services.

Farley, J. 2008. The role of prices in conserving critical natural capital. *Conservation Biology*. 22, pp. 1399–1408

Fisher, B., Turner, R.K. and Morling, P., 2009. Defining and classifying ecosystem services for decision making. *Ecological Economics* 68, pp. 643–653.

Geneletti, D., 2012. Reasons and options for integrating ecosystem services in strategic environmental assessment of spatial planning. *International Journal of Biodiversity Science, Ecosystem Services and Management*, 7(3), pp. 143–149.

Ghazoul, J., 2007. Challenges to the uptake of the ecosystem service rationale for conservation. *Conservation Biology*, 21(6), pp. 1651–1652.

Gibson, C.M. 2012 New times demand new scholarship I: Research universities and civic engagement: A leadership agenda." *Journal of Higher Education Outreach and Engagement*, 16(4), pp. 235-270.

Gomez-Baggethun, E. and Ruiz-Perez, M., 2011. Economic valuation and the commodification of ecosystem services. *Progress in Physical Geography*, pp. 1–16.

Gómez-Baggethun, E., de Groot, R., Lomas, P.L. and Montes, C., 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecological Economics*. 69, pp. 1209–1218.

Greenhalgh, S. and Hart, G., 2015. Mainstreaming ecosystem services into policy and decision-making: lessons from New Zealand's journey. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 3732(June), pp.1–11.

Guerry, A.D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G.C., Griffin, R., Ruckelshaus, M., Bateman, I.J., Duraiappah, A., Elmqvist, T., Feldman, M.W., Folke, C., Hoekstra, J., Kareiva, P.M., Keeler, B.L., Li, S., McKenzie, E., Ouyang, Z., Reyers, B., Ricketts, T.H., Rockström, J., Tallis, H. and Vira, B., 2015. Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences*, 112(24), pp. 7348–7355.

Haines-Young, R. and Potschin, M., 2009. The Links Between Biodiversity, Ecosystem Services and Human Well-Being. In: Raffaeli, D., Frid, C. (Eds.), Ecosystem Ecology: a new synthesis. BES ecological reviews series. Cambridge University Press (CUP), Cambridge

Hansen, R., Frantzeskaki, N., McPhearson, T., Rall, E., Kabisch, N., Kaczorowska, A., Kain, J.H., Artmann, M. and Pauleit, S., 2015. The uptake of the ecosystem services concept in planning discourses of European and American cities. *Ecosystem Services*. 12, pp. 228–246.

Harden, C.P. 2012. Framing and reframing questions of human-environment interactions, presidential address. Annals of the Association of American Geographers 102(4), pp. 737-747.

Harrison, P.A., Vandewalle, M., Sykes, M.T., Berry, P.M., Bugter, R., de Bello, F., Feld, C.K, Grandin, U., Harrington, R., Haslett J.R., Jongman R.H,G,, Luck, G.W., da Silva, P.M., Moora, M., Settele, J., Sousa, J.P. and Zobel, M., 2010. Identifying and prioritising services in European terrestrial and freshwater ecosystems. *Biodiversity and Conservation* 19, pp. 2791–2821.

Hauck, J. , Go¨rg, C., Varjopuro, R., Ratama¨ki, O. and Jax, K., 2013. Benefits and limitations of the ecosystem services concept in environmental policy and decision making: Some stakeholder perspectives. *Environmental Science and Policy*, 25, pp. 13–21.

Hauck, J. Burkhard, S.K., Albert, C., Go¨rg, C., Jax, K., Jensen, R., Fürst, Christine, Maes, J., Ring, I., Hönigová, I., Burkhard, B., Mehring, M., Tiefenbach, M., Grunewald, K., Schwarzer, M., Meurer, J., Sommerhäuser, M., Priess, J.A., Schidt, J. and Grêt-Regamey, A., 2013. HUMAN IMPACT ON EARTH SYSTEMS The Promise of the Ecosystem Services Concept for Planning and Decision-Making. *GAIA - Ecological Perspectives for Science and Society*, 22(July 2016), pp. 232–236.

Häyhä, T. and Franzese, P.P., 2014. Ecosystem services assessment: A review under an ecological-economic and systems perspective. *Ecological Modelling*, 289, pp. 124–132.

Häyhä, T., Franzese, P.P., Paletto, A. and Fath, B.D., 2015. Assessing, valuing, and mapping ecosystem services in Alpine forests. Ecosystem Services. 14, pp. 12–23.

Heffron, S.G. and Downs, R.M. 2012.. Geography for life: National geography standards." Geography Education National Implementation Project. Washington, DC: National Council for Geographical Education.

Hein, L., van Koppen, K., de Groot, R.S. and van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological Economics*. 57, pp. 209–228.

Helliwell, D.R., 1969. Valuation of wildlife resources. *Regional Studies* 3, pp. 41–49

Hubacek, K.and van der Bergh, J., 2006. Changing concepts of land in economic theory: from single to multi-disciplinary approaches. *Ecological Economics* 56, pp. 5–27

Irvine, K., C. Lakhena, C. Phallin, C. Sreyneang, N. Saophuong, N. Putheary, S. Kunthy, and Y. Sophearith, 2010. Integrated Water Resources Management – opportunities and challenges for Cambodia. Water Resources and Development in Southeast Asia. K. Irvine, T. Murphy, V. Vanchan, and S. Vermette, eds., Pearson Learning Solutions, Boston, MA, pp. 108-136.

Irvine, K.N., Chang, C.H., and Das, D. 2016. Waterscapes Asia: Concepts and practices. *Journal of Geography, Environment and Earth Science International*. 5(3), pp. 1-9.

Irvine, K.N., Sovann, C., Suthipong, S., Kok, S., and Chea, E. 2015. Application of PCSWMM to assess wastewater treatment and urban flooding scenarios in Phnom Penh, Cambodia: A tool to support eco-city planning. *Journal of Water Management Modeling*, http://dx.doi.org/10.14796/JWMM.C389.

James, S.P. 2003. Zen Buddhism and the intrinsic value of nature. *Contemporary Buddhism* 4(2), pp. 143-157.

Judkins, G., Smith, M., and Keys, E. 2008. Determinism with human-environment research and the rediscovery of environmental causation. *The Geographical Journal*, 174(1), pp. 17-29.

Lamarque, P., Quétier, F. and Lavorel, S., 2011. The diversity of the ecosystem services concept and its implications for their assessment and management. *Comptes Rendus - Biologies*, 334(5-6), pp. 441–449.

Laurans, Y., Rankovic, A., Billé, R., Pirard, R. and Mermet, L., 2013. Use of ecosystem services economic valuation for decision making: Questioning a literature blindspot. *Journal of Environmental Management*, 119, pp. 208–219.

Limburg, K.E., O'Neill, R.V., Costanza, R. and Farber, S., 2002. Complex systems and val- uation. *Ecological Economics*. 41, pp. 409–420

Lindeman, R.L., 1942. The trophic-dynamic aspect of ecology. *Ecology* 23, pp. 399–418

Linton J. 2014. Modern water and its discontents: a history of hydrosocial renewal. WIREs Water, 1, pp. 111-120.

Liu, S., Costanza, R., Farber, S. and Troy, A., 2010. Valuing ecosystem services. Theory, practice and the need for a transdisciplinary synthesis. *Ecological Economics Reviews.* Book Series: Annals of the New York Academy of Sciences. 1185, *pp.* 54 – 78.

Loc, H.H., Diep, N.T. hong, Can, N.T., Irvine, K.N. and Shimizu, Y., 2016. Integrated evaluation of Ecosystem Services in Prawn-Rice rotational crops, Vietnam. *Ecosystem Services*.

Loomis, J., Kent, P., Strange, L., Fausch, K. and Covich, A., 2000. Measuring the total economic value of restoring ecosystem services in an impaired river basin: Results from a contingent valuation survey. *Ecological Economics*, 33(1), pp. 103–117.

MA (Millennium Ecosystem Assessment), 2005. Ecosystems and human well-being: Synthesis. Island Pres, Washington D.C. World Press Institute.

Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schägner, J.P., Grizzetti, B., Drakou, E.G., Notte, A. La, Zulian, G., Bouraoui, F., Luisa Paracchini, M., Braat, L. and Bidoglio, G., 2012. Mapping ecosystem services for

policy support and decision making in the European Union. *Ecosystem Services*. 1, pp. 31–39.

Malthus, T. 1798. An Essay on the Principle of Population, London (reprinted 1998, Electronic Scholarly Publishing Project, http://www.esp.org).

Mann, C., Loft, L. and Hansjürgens, B., 2015. Governance of Ecosystem Services: Lessons learned for sustainable institutions. *Ecosystem Services*, 16, pp. 275–281.

Margles, S.W., Peterson, R.B., Ervin, J. and Kaplin, B.A., 2010. Conservation without borders: Building communication and action across disciplinary boundaries for effective conservation. *Environment Management*. 45, pp. 1–4.

Partidário, M. R. 2010 TEEB case: Strategic Environmetal Assessment (SEA) for including ecosystem services in coastal management, Portugal, available at: www.TEEBweb.org

Marre, J.B., Thebaud, O., Pascoe, S., Jennings, S., Boncoeur, J. and Coglan, L.,2015. The use of ecosystem services valuation in Australian coastal zone management. *Marine Policy*, 56, pp. 117–124.

Marsh, G.P., 1864. Man and Nature (1965). Harvard University Press, Cambridge MA

Martínez-Alier, J., 1987. Ecological Economics. Basil Blackwell, Oxford. Martínez-Alier,

Martínez-Harms, M.J. and Balvanera, P., 2012. Methods for mapping ecosystem service supply: a review. *International Journal of Biodiversity Science, Ecosystem Services and Management* 8, pp. 17–25

Mascarenhas, A., Ramos, T.B., Haase, D. and Santos, R., 2015. Ecosystem services in spatial planning and strategic environmental assessment-A European and Portuguese profile. *Land Use Policy*, 48, pp. 158–169.

Matzdorf, B. and Meyer, C., 2014. The relevance of the ecosystem services framework for developed countries' environmental policies: A comparative case study of the US and EU. *Land Use Policy*, 38, pp. 509–521.

Max-Neef, Manfred A., 2005. Foundations of transdisciplinarity. *Ecolical Economics*. 53 (1), pp. 5–16.

McCauley, D.J., 2006. Selling out on nature. *Nature*, 443(7107), pp. 27–28.

McHarg, I.L. 1971. Design with Nature. Published for the American Museum of Natural History. Doubleday.

Meadows, D.H., Meadows, D.L., Randers, J., and Behrens, W.W. 1972. The Limits to Growth, Signet, New York.

Mooney, H. and Ehrlich, P., 1997. Ecosystem services: a fragmentary history. In: Daily, G.C. (Ed.), Nature's Services. Island Press, Washington, DC, pp. 11–19

Nahlik, A.M., Kentula, M.E., Fennessy, M.S. and Landers, D.H., 2012. Where is the consensus? A proposed foundation for moving ecosystem service concepts into practice. *Ecological Economics*, 77, pp. 27–35.

Nahuelhual, L, Laterra, P., Villarino, S., Mastrángelo, M., Carmona, A., Jaramillo, A., Barral, P. and Burgos, N., 2015. Mapping of ecosystem services: Missing links between purposes and procedures. Ecosystem services, 13, pp. 162-172.

Naidoo, R., Balmford, a, Costanza, R., Fisher, B., Green, R.E., Lehner, B., Malcolm, T.R. and Ricketts, T.H., 2008. Global mapping of ecosystem services and conservation priorities. *Proceedings of the National Academy of Sciences*. 105(28), pp. 9495–9500.

Naredo, J.M., 2003. La economía enevolución:Historia y perspectivas de las características básicas del pensamiento económico. Siglo XXI,Madrid.

Nelson, E., Mendoza, G., Regetz, J., Polasky, S., Tallis, H., Cameron, D.R., Chan, K.M.A., Daily, G.C., Goldstein, J., Kareiva, P.M., Lonsdorf, E., Naidoo, R., Ricketts, T.H. and Shaw, M.R., 2009. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. *Frontiers in Ecology and the Environment 7*, pp. 4–11

Odum, E.P., 1956. Fundamentals of Ecology. Sounders, Philadelphia

Odum, H.T., 1971. Environment, Power and Society. Wiley, New York

Pagiola, S. and Platais,G.,2007. Payments forEnvironmental Services: FromTheory toPractice. World Bank, Washington.

Pearce, D.W., Markandya, A. and Barbier, E.B., 1989. Blueprint for a Green Economy. Earthscan, London.

Perrings, C., Folke, C. and Mäler, K.G., 1992. The ecology and economics of biodiversity loss: the research agenda. *Ambio* 21, pp. 201–211

Pimentel, D., 1980. Environmental Quality and Natural Biota. BioScience 30 (11), pp. 750–755.

Pittock, J., Cork, S. and Maynard, S., 2012. The state of the application of ecosystems services in Australia. *Ecosystem Services*, 1(1), pp. 111–120.

Plieninger, T., Dijks, S., Oteros-Rozas, E. and Bieling, C., 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy* 33, pp. 118–129.

Portman, M.E., 2013. Ecosystem services in practice: Challenges to real world implementation of ecosystem services across multiple landscapes - A critical review. *Applied Geography*, 45, pp. 185–192.

Radcliffe, S.A. Watson, E.E., Simmons, I., Fernandez-Armesto, F. and Sluyter, A. 2010. Environmentalist thinking and/in geography. *Progress in Human Geography*, 34(1), pp. 98-116.

Rall, E.L., Kabisch, N. and Hansen, R., 2015. A comparative exploration of uptake and potential application of ecosystem services in urban planning. *Ecosystem Services*, 16, pp. 230–242.

Raymond, C.M., Singh, G.G., Benessaiah, K., Bernhardt, J.R., Levine, J., Nelson, H., Turner, N.J., Norton, B., Tam. J. and Chan, K.M.A., 2013. Ecosystem Services and Beyond: Using Multiple Metaphors to Understand Human-Environment Relationships. *BioScience*, 63(7), pp. 536–546.

Rega, C. and Spaziante, A., 2013. Linking ecosystem services to agri-environmental schemes through SEA: A case study from Northern Italy. *Environmental Impact Assessment Review*, 40, pp. 47–53.

Reyers, B., Polasky, S., Tallis, H., Mooney, H.A. and Larigauderie, A., 2012. Finding common ground for biodiversity and ecosystem services. *BioScienc*e 62, pp. 503–507

Rhoton, D. 2004. Interdisciplinary research: trend or transition. Items & Issues, SSRC Publication, 5(1-2), pp. 6-11.

Ridder, B., 2008. Questioning the ecosystem services argument for biodiversity conservation. *Biodiversity and Conservation*, 17(4), pp. 781–790.

Ridker, R.G. and Henning, J.A., 1967. The determinants of residential property values with special reference to air pollution. *The Review of Economics and Statistics* 49 (2), pp. 246–257

Robinson, J. 2004. Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics*, 48, pp. 369-384.

Rolston, H. 1987. Can the East help the West to value nature?." *Philosophy East and West* 37(2), pp. 172-190.

Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Ricketts, T., Bhagabati, N., Wood, S.A. and Bernhardt, J., 2013. Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. *Ecological Economics*. 115, pp. 11–21.

Say, J.B., 1829. Cours complet d'économie politique pratique. Chez Rapylli, Paris

Scarlett, L. and Boyd, J., 2013. Ecosystem services and resource management: Institutional issues, challenges, and opportunities in the public sector. *Ecological Economics*, 115, pp.3–10.

Schägner, J.P., Brander, L., Maes, J. and Hartje, V., 2013. Mapping ecosystem services' values: Current practice and future prospects. Ecosystem Services. 4, pp. 33–46.

Schleyer, C., Görg, C., Hauck, J. and Winkler, K.J., 2015. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. *Ecosystem Services*, 16, pp. 174–181.

Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S. and Opdam, P., 2014. Ecosystem Services as a Contested Concept: A Synthesis of Critique and Counter-Arguments. *Conservation Letters*, 7(6), pp. 514–523.

Schröter, B. Matzdorf, B., Sattler, C. and Alarcon, G.C., 2015. Intermediaries to foster the implementation of innovative land management practice for ecosystem service provision - A new role for researchers. *Ecosystem Services*, 16, pp. 192–200.

Schumacher, E.F., 1973. Small is Beautiful: Economics as if People Mattered. Blond and Briggs, London.

Seifert-Dähnn, I., Barkved, L.J. and Interwies, E., 2015. Implementation of the ecosystem service concept in water management – Challenges and ways forward. *Sustainability of Water Quality and Ecology*, 5, pp.3–8.

Seppelt, R., Dormann, C.F., Eppink, F. V., Lautenbach, S. and Schmidt, S., 2011. A quantitative review of ecosystem service studies: Approaches, shortcomings and the road ahead. *Journal of Applied Ecology*, 48(3), pp. 630–636.

Sitas, N., Prozesky, H.E., Esler, K.J. and Reyers, B., 2013. Opportunities and challenges for mainstreaming ecosystem

services in development planning: perspectives from a landscape level. *Landscape Ecology*, pp. 1–17.

Skole, D.L. 2004. Geography as a great intellectual melting pot and the preeminent interdisciplinary environmental discipline. *Annals of the Association of American Geographers*, 94(4), pp. 739-743.

Solow, R.M., 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics* 70, pp. 65–94

Stern, N., 2006. Stern Review on the Economics of Climate Change, UK

Swyngedouw, E. 1999, Modernity and hybridity: Nature, Regeneracionismo, and the production of the Spanish waterscape, 1890-1930. *Annals of the Association of American Geographers*, 89(3), pp. 443-465.

TEEB foundations, 2010. The economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London and Washington D.C.

Turner, R.K. and Daily, G.C., 2008. The ecosystem services framework and natural capital conservation. *Environmental and Resource Economics*, 39(1), pp. 25–35.

Turner, R.K., Van den Bergh, J.C.J.M., Soderqvist, T., Barendregt, A., Van der Straaten, J., Maltby, E. and Van Ierland, E.C., 2000. Ecological-economic analysis of wetlands: Scientific integration for management and policy. *Ecological Economics*, 35(1), pp. 7–23.

Turner, R.K, Paavola, J., Cooper, P., Farber, S., Jessamy, V. and Georgiou, S., 2003. Valuing nature: Lessons learned and future research directions. *Ecological Economics*, 46(3), pp. 493–510.

Turner, R.K., Georgiou, S. and Fisher, B., 2008. Valuing Ecosystem Services: The Case of Multi-Functional Wetlands. Earthscan, London, Sterling.

Turnhout, E., Waterton, C., Neves, K. and Buizer, M., 2013. Rethinking biodiversity: From goods and services to "living with." *Conservation Letters*, 6(3), pp. 154–161.

Verburg, R., Selnes, T. and Verweij, P., 2016. Governing ecosystem services: National and local lessons from policy appraisal and implementation. *Ecosystem Services*, 18, pp. 186–197.

Wainger, L. and Mazzotta, M., 2011. Realizing the potential of ecosystem services: A framework for relating ecological changes to economic benefits. *Environmental Management*, 48(4), pp. 710–733.

Waters, R., Lusardi, J. and Clarke, S., 2012. Delivering the ecosystem approach on the ground – an evaluation of the upland ecosystem service pilots. *Natural England Research Reports*, number 046. , p.58.

Westman, W.E., 1977. Howmuch are nature's servicesworth? *Science* 197, pp. 960–964

White, L., Jr, 1967. The historical roots of our ecological crisis', *Science* 155, pp. 1203-1207.

Whittington, D. 1998. Administering contingent valuation surveys in developing countries. *World Development*, 26 (1), pp. 21-30.

Whittington, D. Briscoe, J., Mu, X. and Barron, W., 1990. Estimating the willingness to pay for water services in developing countries: a case study of the use of contingent valuation surveys in Southern Haiti. *Economic Development and Cultural Change*, pp. 293-311.

Chapter 3

Case Studies

Case Study No. 1

Monetary Valuation using Revised Market Method

CONTENTS

3.1 Introduction

A number of definitions for ES can be found in the literature (Hayha *et al.*, 2015) of which three are commonly cited, *e.g.*, the conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfill human life (Daily 1997); the benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza *et al.*, 1997); or more concisely, the benefits people obtain from ecosystems (MA 2005).

Guided by such goals, several valuation frameworks have been developed, of which TEEB's *Total Economic Value* (TEV) being one of the most commonly applied. Using standard accounting units (such as money), TEV enables the comparison between ES and other marketed goods or services. There are three clearly differentiated valuation approaches in this framework: (1) revealed preference; (2) cost-based; and (3) stated preference. These different economic techniques are adopted to handle ES with contrasting characteristics. For instance, the *market price method*, which is an example of the revealed preference approach, is widely used for those services with real markets such as crops, livestock or forestry products. Conversely, for others without well-established markets such as cultural or spiritual values of landscapes, stated preference methods such as contingent valuation methods are more appropriate. These two techniques, as well as related methods, have strengths, weaknesses as well as their specific validity. Nevertheless, yet another methodological review is not the intent of this paper because such reviews are readily available (*e.g.*, Farber *et al.*, 2002; Freeman *et al.*, 2003; Hadley *et al.*, 2011; Atkinson *et al.*, 2012). Rather, this paper looks at how to overcome some of the challenges faced in applying ES through the use of an integrated socio-economic/biophysical visualization and statistical approach.

Along with the dramatic increase in the number of ecosystem valuation publications such as Environment Valuation Reference Inventory (Liu *et al.*, 2010), mapping of ES values also constitutes a fast-growing body of literature, in particular with the advancement of GIS and other earth observation techniques. How natural benefits vary across a geographical area has become one of the most active topics in the environmental research agenda (Troy and Wilson, 2006). Attempts have been made to map the use values of timber production, carbon sequestration and

natural hazard protection (Seidl et al, 2007; Teich and Bebi, 2009) as well as non-use values such as cultural, educational or spiritual services (Fagerholm and Kayhko, 2009; van Berkel and Verburg, 2014).

The objectives of this case study are to analyze how economic values of ES can be calculated and mapped at the district scale, focusing on the PRRC areas of the An Minh district, Vietnam and to examine how applying ES valuation framework can improve land use planning decisions. The PRRC scheme includes rice and prawn crops periodically cultivated within the course of a year in accordance with the specific hydrologic conditions, in particular, saline concentration. The research was initiated with the acquisition and processing of Landsat 8 data to identify the PRRC areas in An Minh District. The validation of land cover classification was controlled by ground truth points. Secondly, within the framed ecosystem of PRRC, all the ES contributing to crop yield were considered, including, but are not limited to, water and nutrition supply, nutrient cycling, hydrologic regulation, and pest control. Each of these, individually, does not appear in any well-established markets for purchase or exchange. However, as a bundle, they contribute to the generation of rice and prawn crops which are marketable. Therefore, a common value for all the associated ES is assigned and reflected partially in the total harvest revenues. This assumption is the prerequisite to apply the direct market price methods. Ubiquitously 100 % of the crop revenues have been used as the proxy to evaluate agriculture-related ES (Sumarha and Hein 2014; Hayha *et al.*, 2015). However, this assumption is prone to overestimation because it neglects the human participation through capital and labor. Furthermore, in the context of an agricultural ecosystem, anthropogenic contributions do not only bear economic significance but social values as well, such as family and communal tillage experience. Clearly, direct market price methods are not originally designed to handle these values. This shortcoming raises questions about the validity of the market approach in valuing ES.

To overcome the challenge, the author first subtracts the total crop revenues by associated costs to account for the human contributions which, in turn, makes the economic values of ES better estimated (TEEB 2010, EC 2013). Information about these costs was collected through face to face interviews. Secondly, these costs were further analyzed to uncover the underlying socio-

economic relationships associated with the local context. This analytical framework constitutes a *modified market approach,* in which the author strive to integrate new ways to understand and appropriately evaluate ES and thereby make it a more comprehensive, yet practical decision-making tool, particularly for planning practitioners. The analytical framework highlights both the biophysical performance and social integrity of ES and in this way addresses the nature-social dualism that often is a barrier to effective environment management. Numerical results were synthesized in thematic maps for better visualization and communication with stakeholders to re-evaluate the current land use planning and to shed useful light on challenges in both natural suitability and social integrity.

3.2 The research area

Kien Giang is a province of Vietnam, located on the southwestern side of the Mekong Delta, with the provincial capital being Rach Gia City. The total area is about 6,299 km² of which 66% of the natural area is agricultural. The population is about 1,634,043, of which 22 % live in the urban area. The research area is An Minh district, located on the west coast of the province. The district is bordered by An Bien District in the North, U Minh Thuong district in the East and the West Sea in the west, with 37 km of coastline. The district consists of 11 communes (smaller administration units under districts) with the total area of 59,000 hectares. Figure 3.1 shows the location of the research area with the identification of Kien Giang within Vietnam's Mekong Delta.

An Minh district was chosen for this research due to its large cultivated area as well as its high productivity of PRRC. (BCS, 2015). Historically, rice is the predominant crop of Kien Giang province. However, due to its unique hydrologic conditions with periodic salinity intrusion during dry seasons, the productivity and values of rice crops are heavily affected, especially for coastal areas such as the An Minh district. The situation has become even worse in recent years due to climate change impacts which were mainly storm surges and salinity intrusion (Vietnam National Mekong River Commission, 2011). Recently, the provincial government has initiated several measures to cope with this situation, one of which is the shifting from a rice intense tillage scheme to PRRC [(1)]. The concept behind this rotation is to combine crops with different water

requirements and salinity adaptability to cut down on land idle time and to increase crop yields in the course of a year.

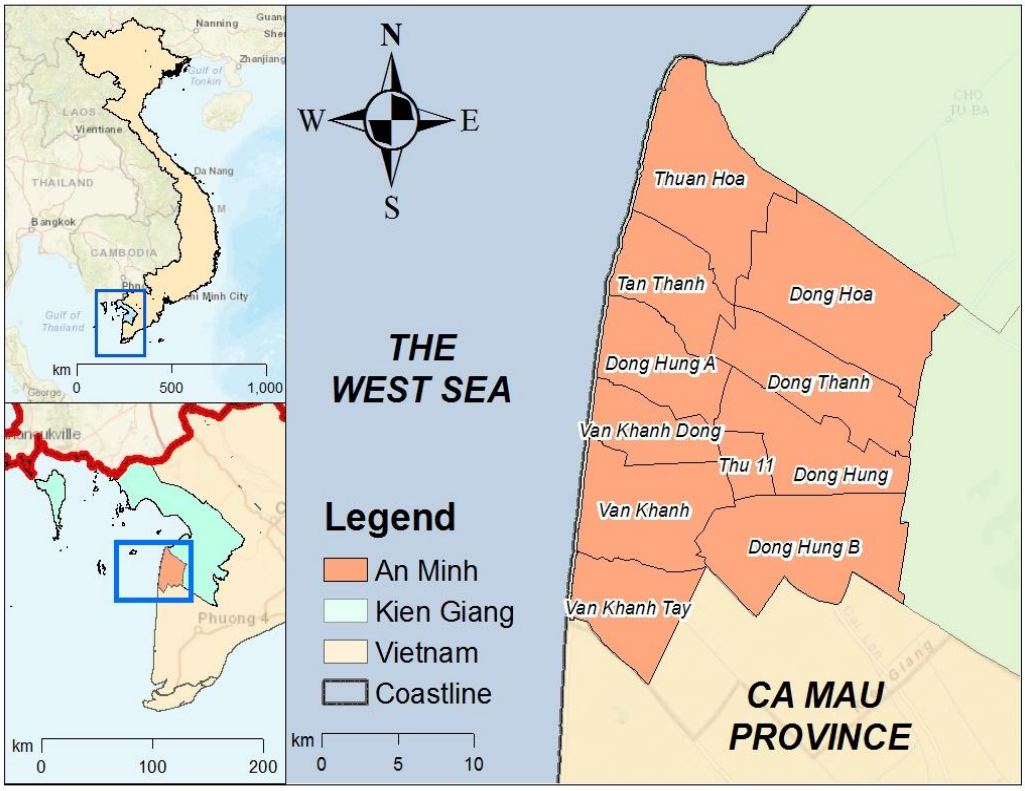


Fig. 3.1 An Minh district location

3.3 Methodology

3.3.1 Remote Sensing and Geographical Information System

The first task of this case study was to identify the areas of PRRC in An Minh district via remote sensing. Two Landsat 8 images with 30 m x 30 m resolution taken on 25/11/2013, 27/12/2013, 24/08/2014 and 21/04/2015 (cloud ratios: 17.73 %, 0.16 %, 39.07%, and 2.21 %, respectively) were acquired from the United States Geographical Science (USGS) website. The chosen dates correspond with the cultivating time of respective crops [(2)]. Firstly, the author filtered the images using the median method to screen random noise and outliers. Then, pre-processing imagery analysis was conducted by calculating the *Normalized Difference Vegetation Index* (NDVI) and the *Modified Normalized Difference Water Index* (MNDWI) to identify vegetated areas and water bodies in the research area (Farrar and Nicholson, 1994; Xu, 2006). Next, image supervised classification

was conducted using a Maximum Likelihood algorithm following the creation of training sample objects. These sample objects were created based on empirical classification indicators: colors, shapes, patterns, size, location and typical characteristics combined with field survey results. Finally, each classified images were overlaid to produce a comprehensive land cover map of the research area. Image classification results were validated using global accuracy and Kappa indexes (Congalton, 1991).

3.3.2 Field Survey and Household Interviews

The field survey had two objectives: to verify (ground truth) remote sensing analysis results and to gather information regarding farming activities, including associated costs, crops selection, *etc.* as well as respondents' social and demographic characteristics. A total of 50 households were surveyed via face to face interviews using semi-structured questionnaires. The households were purposely chosen based on their tillage practices in recent years. Hence, the surveyed respondents consisted of those with certain experience (at least five years) with PRRC which cover all 11 communes throughout the landscape of the An Minh district. The interviews started with an introduction about the importance of ecosystems, the associated ES, as well as the purpose of the research. Respondents were then asked about basic demographic characteristics *i.e.,* names, genders, age, education, *etc.* The next section of the questionnaire examined issues of PRRC such as agricultural calendars, seed selection, and schedule for each crop. Finally, the associated costs (fixed and variable), as well as averaged yields and benefits in recent years, were discussed. Each interview took approximately 40 - 50 minutes.

3.3.3 Evaluation methods

A. Biophysical and Economic valuation

In this chapter, the focus is on the ES that are associated with PRRC. These services include but are not limited to provisioning services: water and nutrition; regulating services: nutrients circulation, and climatic regulation. These conditions combined with proper farming activities could generate crop yields which are direct benefits for society. Because of the absence of real markets for these services and the desire to avoid double counting during the calculation processes, we used the proxy of annual crop yields per unit area to represent the biophysical units

of incorporated ES mentioned above. Subsequently, the author calculated the economic values via resource rent method (European Commission, 2013). One recent study also used a similar approach to calculate multiple services in the agriculture ecosystem of Central Kalimantan province, Indonesia (Sumarga *et al.*, 2015). The economic values of ES are calculated using:

$$RR = TR - (FC + VC + OC) \qquad \text{(Eq.1).}$$

Where RR = Resource Rent, TR = total revenue from crops, FC = Fixed costs, VC = Variable costs, OC = Opportunity Costs.

B. Statistical Analysis

The novelty of the presented method is that the author not only calculated the biophysical and economic values and visually project them on GIS maps (Burkhard *et al.*, 2012; Remme *et al.*, 2014, Costanza *et al.*, 1997; de Groot *et al.*, 2012) but also looked at the relationships between these components and the social-demographic background of respondents. This approach has been applied to investigate cultural and spiritual services of the landscape (Chan *et al.*, 2012; Martin-Lopez *et al.*, 2012; Ryan, 201). Willingness to pay for landscape ES was also explored using a similar approach (Loomis *et al.*, 2000).

At first, the social-demographic characteristics *i.e.,* age, gender, education were categorized into absolute values and proportions. Further, the author used factor analysis methods to detect and represent the underlying pattern of these attributes and associated costs in PRRC. For better clarification, information gathered was initially divided into two sub-groups of variables: qualitative and quantitative. The first group, which describes the social characteristics of respondents, consists of experience, age, education, location, selected crop seeds and cultivation calendar. This group consists of both continuous and categorical variables, therefore was handled using factor analysis for mixed data (FAMD) (Le *et al.*, 2008; Husson *et al.*, 2015). The latter which consists of 9 variables (3 different types of costs, the productivity of two crops, cultivated area, market prices of crops and extra revenue from by-products) representing the economic aspects of PRRC, all of which are continuous variables and thus was analyzed through principal component analysis (PCA). The by-products consist of straw or leftovers of crops that could be used as supplementary food for farm animals. The sample verification of data was conducted via

significant values in Bartlett's Test for Homogeneity of Variances (Bartlett, 1937) and Kaiser-Meyer-Okin Measure of Sampling Adequacy (Tabachnik and Fidell, 2001). To confirm the adequacy of the principal components generated, the analysis followed the Kaiser Criterion (Hair *et al.*, 1998). Finally, to identify possible bundles of individuals sharing similar patterns, the author performed hierarchical cluster analysis (HCA) through Euclidean distance and Ward's agglomerative methods using the coordinates of the three most significant principal components respectively. All of the analyses above were conducted using FactomineR (Le *et al.*, 2008; Husson *et al.*, 2015; R Core Team, 2015).

Box 3.1 Additional information concerning PRRC system

(1) PRRC was discovered by chance in Ca Mau Province when farmers found brackish water prawns in their fields after harvesting the rice crops. The prawns are believed to have followed the irrigation stream to enter the fields.

(2) The rice crop usually starts from November until February depending on hydro-meteorological conditions to utilize storm water for irrigation and desalination. The prawn crop starts from February until November to cope with dry weather and salinity intrusion. (field survey)

3.4 Results

3.4.1 Satellite images processing

Landsat 8 images were obtained from the USGS website (http://landsat.usgs.gov/). Figure 2 shows one example image in its primary form. The area of An Minh district was extracted from the original image pre-processed by NDVI and MNDWI. These indicators were acquired by synthesizing the reflectance spectra of different color channels of the satellite images.

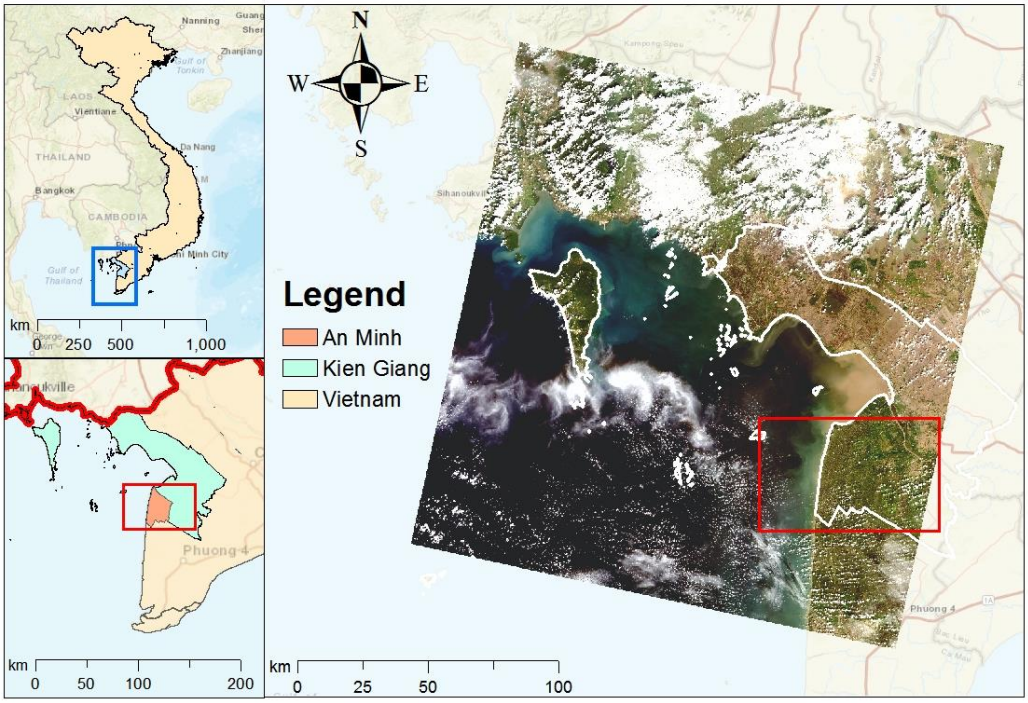


Fig. 3.2 Landsat 8 image acquired from USGS Website

In particular, to obtain NDVI values, the integration of reflectance spectra values of near infrared and red channels was conducted. The higher this index, the denser the vegetated area. Similarly, reflectance spectra values of near infrared and green channels were combined to generate MNDWI values. Higher values of MNDWI index signify deeper water (Parida *et al.*, 2008; Xu, 2006). Therefore, NDVI and MNDWI were used to identify vegetated areas such as forests, paddy fields and water bodies such as rivers, canals, and aquaculture fields throughout the landscape.

In the An Minh district, because of the rotation between rice and prawn crops, the corresponding land cover classes would also be periodically shifted between vegetation and water bodies, which accordingly presents a challenge to distinguish PRRC from other land covers. Hence, NDVI and MNDWI value maps for multi-temporal imagery were generated. Figure 3.3 show results of NDVI and MNDWI on Nov/25/2013 and Aug/24/2014 images.

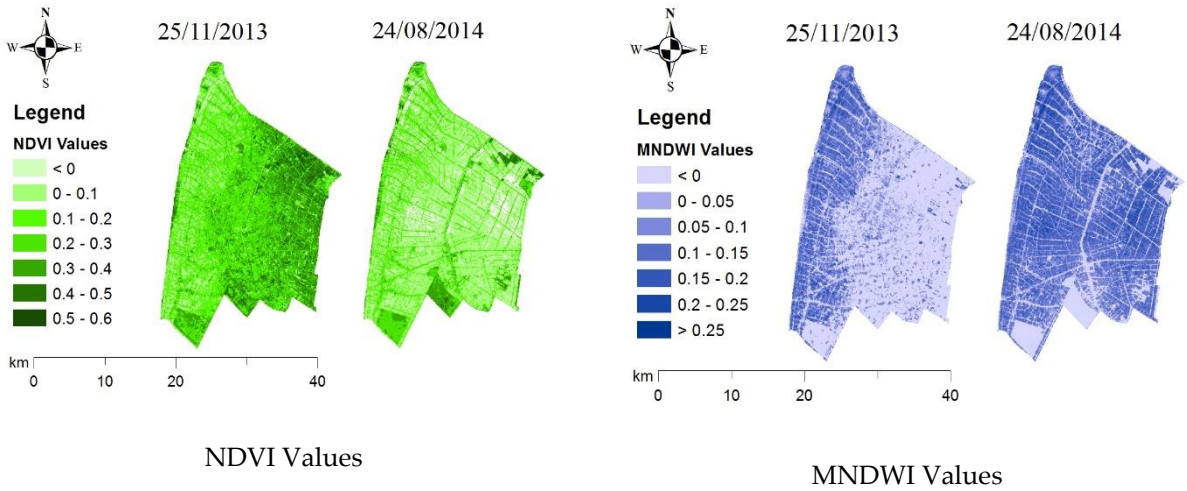


Fig. 3.3 Index Images

It is noticeable that there are certain locations on the east side of the area, of which the values of the indices differ between the two periods. More specifically, the NDVI values for these regions are higher in the November image than in the August image and vice versa for MNDWI values. This difference is relevant with the changes in land cover of PRRC which gives an essential key to classify PRRC among other vegetated areas such as paddy fields, forests and water bodies such as aquaculture or rivers for which the indices remain unchanged.

Sample objects were then generated to train ArcGIS to classify different land cover types. Supervised image classification using the Maximum Likelihood algorithm was employed to develop the maps of each period in Nov 2013 and August 2014 with classified land covers as depicted in Figure 3.4.

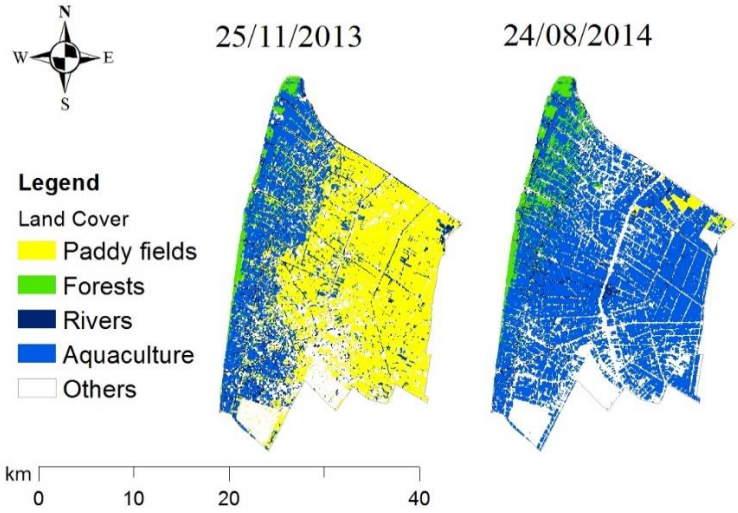


Fig. 3.4 Results from supervised classification of multi-temporal images

PRRC is recognized as areas with different land cover types between two images. In the November image, PRRC areas are classified as *Paddy fields* whereas in August they are classified as *Aquaculture*. The four classified images were overlaid to generate the overall land cover map of the An Minh district. Classification validity was confirmed via field surveys and observations with GPS handheld devices to accurately georeference the sites. This was done alongside interviews with the farmers to collect data for farming practices, the results of which will be discussed in section 3.2.

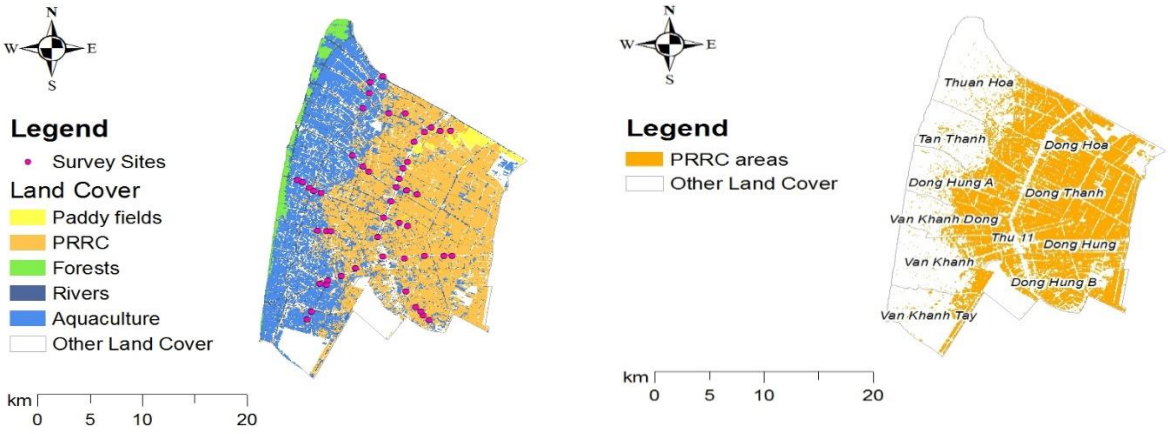


Fig. 3.5 Land cover and observation locations

In total, field observations were done at 50 locations with different land cover types. The global accuracy of this validation process was 86 % with a Kappa index of 0.72. For PRRC, specifically, these values were 92.59 % and 0.85, respectively. Within the research area, Dong Hoa is the commune with the largest PRRC area with 6,667.28 ha which accounts for 26.58 % of the total PRRC area of the An Minh district. The second and third largest PRRC areas are located in Dong Thanh and Dong Hung B with 4,382.3 and 4,369.64 ha, respectively, each of which accounts for approximately 17 % of the total PPRC area. Conversely, the smallest identified area lies in Van Khanh Tay commune with 457.49 ha that accounts for 1.82 % of the total PRRC area. Shown in Figure 3.5 is the final land cover map and the locations of our field observation sites.

3.4.2 Characteristics of Respondents

The survey was completed with 50 interviews covering all 11 communes. Seven respondents were female which accounted for 14 % of the sample. This gender imbalance is in line with the arbitrary number of men participating in the agriculture labor force. The average age is 46 and the majority of individuals are from 40 – 49 that accounts for 34 %.

Regarding cultivation experience, those living on the west side of An Minh district are likely to be more experienced with PRRC (10 – 19 years). This group accounted for 36 % of the respondents. However, the majority of respondents had less experience (5 – 10 years) and had just adopted the PRRC model, following the land use policy of the government. Previously, they had been cultivating double rice crops and other kinds of vegetation crops. Regarding educational background, 48 % of respondents were either illiterate or had an elementary level education, while three respondents had a high school level education, and only one respondent had been professionally trained about aquaculture.

3.4.3 Biophysical and Economic Indicators

Crop yields were used as appropriate proxies to indicate biophysical units for ES evaluation (Hayha *et al.*, 2013; Sumarga *et al.*, 2015). The data on crop yields were converted into unit productivity per hectare for standardization. The first four columns of Table 3.1 show the crop yields as well as averaged selling prices of each crop. The highest productivity of rice crop was 4,630 kg/ha in Dong Hoa Commune and 4,078 kg/ha in Dong Hung. Regarding prawn crops,

these figures were 347 kg/ha in Thuan Hoa and 337 kg/ha in Dong Hung B. The values in the table are averaged from the questionnaires and shown according to respective communes. Information regarding yields and costs are collected from the interviews. Comparison with market prices will be difficult for various reasons such as: the type of seed used, the size of the prawn batches and market volatility as well. Moreover, the prices also depend on if farmers sell their crops to state-owned factories or individual dealers such as restaurants. These factors would call for a much more intensive economic research which is far beyond this case study scope.

The Fixed Costs (FC) are the long-term investments consisting of canals and ponds dredging costs, machines (tractors) purchase, irrigation system installation. The Variable Costs (VC) are associated with periodical expenses such as crop seeds, labor, fertilizers, and pesticides. The Opportunity Cost (OC) is defined as the foregone benefits, which was estimated by the average land rental cost of the respective areas. The introduction of OC was to evaluate the capacity of the ecosystem in supporting a substantial livelihood compared to income from land leasing. Columns 5 through 8 in Table 3.1 shows the mean values of these costs in each commune. In general, VC accounts the largest portion, followed by OC and FC. Regarding the municipalities, Dong Hung had the highest total cost (2339.62 USD/ha/year) whereas Dong Thanh had the lowest cost (1675 USD/ha/year).

On FC, Van Khanh Tay had the highest value (121 USD/ha/year), and Dong Thanh had the lowest (67.73 USD/ha/year). Regarding variable costs, Dong Thanh also had the lowest value (818.43 USD/ha/year) whereas Dong Hung respondents spent the most (1483.14 USD /ha/year). Last but not least, Dong Hoa had the highest land rent (887.78 USD/ha/year) whereas Thu 11 was the cheapest location to rent PRRC land (745.3 USD/ha/year).

The total revenues (TR) value in Eq.1 is the summation of the multiplication of each crop yield by their respective selling prices. Finally, ES economic values are obtained by subtracting total revenues with the total costs. The last 3 columns in Table 1 display the minimum, maximum and mean values of ES economic values of which units were also converted into USD/ha/year.

The averaged economic values of ES reflected by resource rent values (RR) in 11 communes is 1183 USD/ha/year. Among the municipalities, Van Khanh Dong and Thuan Hoa communes had

the highest ES values being 2007 and 1542 USD/ha/year. The lowest value of ES was approximately 901 USD/ha/year found at Dong Thanh commune.

Table 3.1 Economic values of ES in USD

Commune	Crop Yields		Selling Prices		Associated Costs				Economic values of ES		
	Rice	Prawn	Rice	Prawn	FC(*)	VC(*)	OC(*)	Total	Min	Max	Mean
Dong Hoa	46.30	3.01	23.27	880.68	69.13	1164.2	887.7	2121.1	761.13	1179.5	923.22
Dong Hung	40.78	2.75	22.77	844.15	79.86	1483.1	776.6	2339.6	200.08	2529.2	917.42
Dong Hung A	20.06	2.34	22.27	800	82.92	1205.0	771.6	2059.5	412.68	1946.9	1136.5
Dong Hung B	35.8	3.37	21.55	781.82	73.55	1213.6	754.0	2041.2	147.36	1432.8	1022.23
Dong Thanh	32.7	3.31	24.59	786.36	67.73	818.43	789.1	1675.3	269.48	1562.8	900.99
Tan Thanh	34.98	3.13	20.36	787.88	76.38	972.46	789.1	1837.9	1005.1	1956.7	1490.48
Thu 11	38.58	2.06	23.41	988.64	91.28	1166.3	745.3	2002.9	733.16	1210.5	971.85
Thuan Hoa	34.89	3.47	22.45	836.36	101.5	994.6	824.2	1920.3	749.02	2852.0	1542.89
Van Khanh	17.13	3.3	23.18	881.82	93.86	1006.1	736.5	1836.5	957.82	2691.4	1487.26
Van Khanh Dong	30.86	2.53	24.64	893.94	79.4	909.91	818.3	1807.6	1453.7	2883.0	2006.7
Van Khanh Tay	13.89	3.32	22.73	863.63	121.7	1294.6	876.8	2293.1	193.18	1884.3	1038.74

Values in the table have been converted into US dollars (USD) from Vietnam dong (VND).
1 USD ~ 22,000 VND
(*)FC=fixed costs, VC=variable costs, OC=opportunity cost

3.4.4 Spatial Distribution

Rice yields were higher on the east side of the study area and vice versa for prawn yields. More specifically, communes with the highest rice yields were Dong Hoa and Dong Hung with 46 and 40 tons/ha/year. With respect to prawn production, Thuan Hoa and Dong Hung B had the highest annual yields with 347 and 337 kilograms/ha. These differences partially reflect the hydrologic conditions variations across the research area (Figure 3.6).

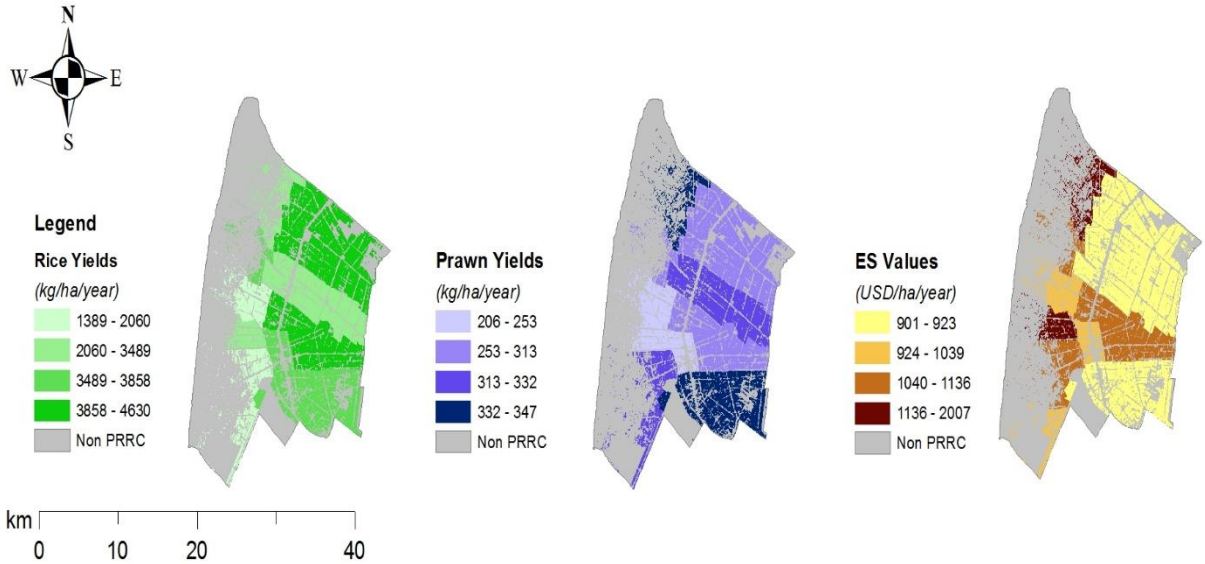


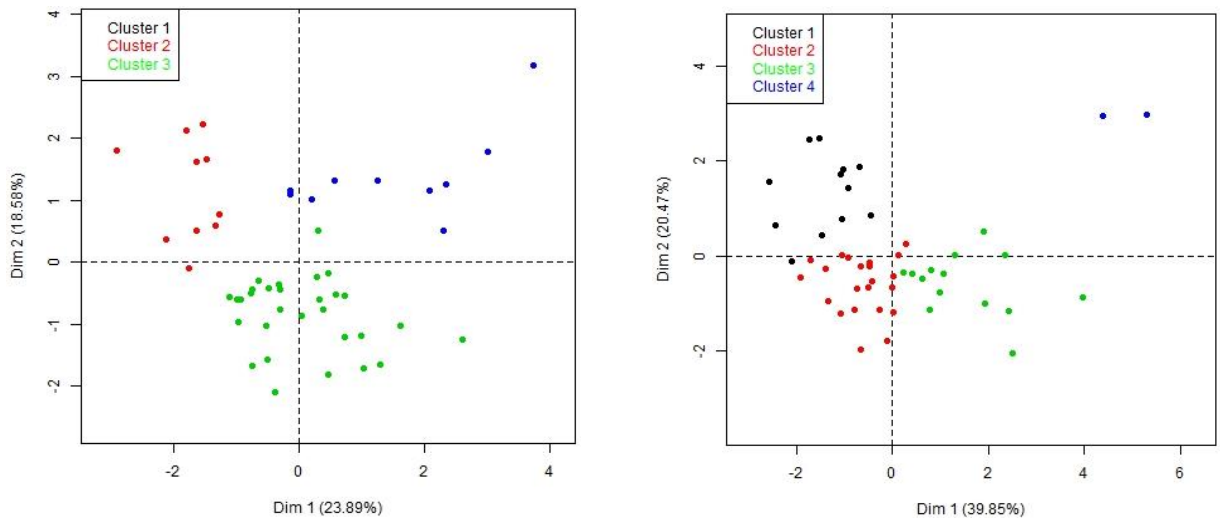
Fig. 3.6 Spatial distribution of crop yields and ES values

Regarding the farming expenditures, the highest values were distributed in the southeastern communes, in particular, Thu 11 and Dong Hung B had the highest figures for total costs. This trend relates to the cultivation experience dissimilarities, especially with prawn crops throughout the landscape. In fact, one of the respondents shared his thoughts about PRRC application. His family had been cultivating rice for generations, but he had shifted to PRRC 10 years ago following the government policies although he had been reluctant. This incident motivated us to explore social attributes of the local community and the relationships with farming practices.

Regarding the economic values of ES, its distribution is more correlated with the prawn yields than that of rice crops. Notwithstanding, Dong Hung B is one exception where despite having high prawn yields the commune can generate relatively low ES economic values. This difference is because of the highest cost incurred during the cultivation practice. All of these dissimilarities signify the imbalance between rice and crops on associated costs, selling prices, and also the social preferences in the local context of the An Minh district.

3.4.5 Factors and Bundles Analyses

Initially, the author considered all the information collected from the questionnaire interviews. Following Kaiser's criterion, the number of variables decreased to six qualitative variables and seven quantitative variables. For qualitative variables, the first three factors accounted for 58.59 % of the variance. The first factor (23.88% of the variance) was explained by the socio-demographic characteristics of respondents' *i.e.*, age, education and years of farming experience. The second factor (18.58 % of variance) represents the cultivation practice of respondents through the selection of crops and calendar. The locations explain the last component which contributes 16.12 % of extracted variance. Then a new coordinate system was sketched using two factors / principal components. All data points/individuals were projected into this new coordinate system constituting the *factor map.* From Figure 3.7(A), data points with similar characteristics are grouped into separate clusters using HCA. The decision on the number of clusters are decided by the Ward's criterion (Husson *et al.*, 2010). Points representing individuals that are closest to the barycenter of each clusters clouds are chosen as representatives.



A. Qualitative Variables B. Quantitative Variables

Fig. 3.7 Factor maps of PCA

Regarding PCA for quantitative variables, the first two factors cover 60.32 % of data variance. The first factor which accounts for 39.85 % of inertia is contributed by cultivated area, prawn productivity, fixed costs, and extra revenue from the selling of bi-products. The second axis which accounted for 20.47 % of inertia is explained by the rice productivity, variable costs, and market price of prawn. Shown in Figure 3.7(B) is the factor map for the HCA applied for quantitative variables. Similar to the qualitative factor map, barycenter closest points (individuals) are chosen as cluster representatives (Table 3.2)

Table 3.2 PCA representative data points

Qualitative Variables						
Cluster	Age	Edu[(a)]	Exp[(b)]	Seed[(c)]	Calendar[(d)]	Location
1	38	Secondary	15	MBD	2nd	Coast
2	62	Primary	30	Others	1st	In-land
3	54	High school	20	MBD	1st	Coast

(b) Exp = cultivation experience in years

(c) MBD are codenames of the most popular rice seeds

(d) The 1st cultivation calendar usually starts from October, and the 2nd one starts from November every year.

Quantitative Variables							
Cluster	RY	PY	FC	VC	ER	PP	Area*
1	46.3	2.89	119	1300	0	9	10368
2	23.15	2.89	82	1048	0	8	15552
3	31.72	2.74	60	707	0	8	23328
4	54.01	1.54	62	1021	1500	12	25920

RY = rice yield, PY = prawn yield, FC = fixed costs, VC = variable costs, ER = extra revenues from bi-products, PP = prawn price

(*) Area = area under PRRC in square meters

Among 3 clusters of data in Fig 3.7 (A), group 1 was characterized by the youngest age and experience, prefer the 2nd cultivation calendar and MBD rice seed. People with the highest experience, age, and lowest education level fall into group 2. This group prefers other seeds and the 1st calendar. Middle-aged people with a moderate educational attainment that prefer the 2nd cultivation calendar and prefer MBD seed belong to group 3. Cluster 2 represents inland communes whereas 1 and 3 represent coastline ones.

In the case of Fig 3.7 (B), group 4 was the most outstanding with extra revenue from by-products. The bi-product for this household is mainly straw for which the amount is relevant to rice crop yields and cultivated areas. This group also had the largest RY, area, and PP whereas prawn yield and FC were the lowest. Groups 1 through 3 share similar patterns in prawn yield. None of these had extra revenue. Group 1 was characterized by higher rice yield and associated costs but also with the smallest area. Group 2 has the 2nd smallest figures in fixed costs and regions. Group 3 had the smallest figure for variable costs yet the 2nd largest cultivated areas. Of the 3 observations chosen, group 1's representative had the highest ES values, followed by group 3's and group 2's. Group 4's had the smallest ES values.

By synthesizing the results of the principal components above, the author has made efforts to describe the most typical tendencies of high ES values regarding socio-economic background and cultivation practice. More specifically, regarding social attributes, those who are middle age, with 10-19 years of farming experience and have an average level of education are more likely to have higher ES values. With regards to economic aspects, ES values tend to be higher for those who can meet the following conditions: keeping the costs reasonably low, having higher yields for smaller areas, having higher selling prices for prawn yields.

There are, nevertheless, cases which are not in accordance with our detected pattern because 100 % of the data variance cannot be captured and explained by only two binary vectors. In fact, there are other circumstances such as disease, natural disasters such as floods or droughts (which were not included in the scope of this research) that could have been held responsible for the dissimilarities from the main trend.

3.5 Discussions

3.5.1 Implications of Spatial Analysis Techniques

Remote sensing, GIS, and Earth observation techniques have been utilized in ES studies. These techniques are employed from identifying sub-areas of interest using image classification algorithms, and visualizing tools to effectively display the spatial pattern of ES (Hayha *et al.*, 2015; Sumarga and Hein, 2014; Tuan *et al.*, 2015; Plieninger *et al.*, 2013, Kuenzer and Tuan., 2013). In this research, we demonstrated an efficient workflow to recognize a rotational crop cultivation areas using remote sensing. First, we applied NDVI and MNDWI to provide a preliminary recognition of the distribution of PRRC in the landscape. Then, image classification using a Maximum Likelihood algorithm with controlled ground points for validation was conducted. The novelty of this approach is the combination of NDVI and MNDWI, each of which, is traditionally used to recognize either vegetation or water bodies, respectively (Thi *et al.*, 2008; Parida *et al.*, 2008; Xu 2006). We further refined the NDVI/MNDWI classification based on field observations conducted alongside farmer interviews, which enhanced the accuracy and reliability of image classification for areas with seasonal changes in land cover such as the PRRC.

3.5.2 Integrated Market Method

The presented case study sought to apply and improve the market price approach for assessing ES which are associated with a regular agricultural cultivation practice. In addition to multiplying the market prices in the final calculation of ES values, we explicitly analyzed their contributions by FAMD and PCA to explore the socio-economic and production factors affecting these values (Helian *et al.*, 2011; Liu *et al.*, 2010; Schagner *et al.*, 2013).

In general, income from prawn accounts for larger proportions of total revenues because of their higher selling prices compared to rice. We intentionally chose to use the term sale price over market price since the external market does not entirely decide its magnitude. Rather, they covariate with the sizes of the prawns which are related to how long they are grown. Particularly, keeping the prawn longer means farmers have to take higher risks of diseases and mortality. Conversely, selling a smaller sized prawn could reduce the risks but would result in lower income as a tradeoff.

Regarding rice crops, the selling price remains relatively more stable owing to its characteristic as a national commodity and that its production relates to national food security objectives. Hence, the productivity of rice had substantial loading in the construction of the principal component in PCA together with cultivated area and extra revenues from by-products.

All of the findings above could not have been discovered if it had not been for the integration of factor analyses into the traditional market price method. This demonstrated the benefits of applying PCA to explore the underlying structure of the data and unfold the relationships between socio-economic, demographic, and production variables.

3.5.3 Benefit Transfer Support

From the presented calculations, the biophysical units and economic values of ES associated in PRRC areas were obtained. In recent years, PRRC has been commonly cited as an adaptive cultivation scheme in coping with a climate change impact *i.e.,* salinity intrusion for coastal areas. Our findings would then be relevant to inform land use decision makers of the capacity of the associated ES in PRRC regarding added economic values. Furthermore, these values could serve as transferable benefits to support future studies about ES evaluation in the Mekong Delta (Wilson and Hoehn 2006: Troy and Wilson 2006; Richardson *et al.*, 2014).

3.5.4 Social Integrity

There have been critical debates over the cultivation of rice crops and PRRC in the area. The first consideration has been the traditional and predominant tillage activity of the community for generations. However, the yields recently have decreased due to the change in hydrologic conditions, which likely to grow even worse in the future (Vietnam National Mekong River Commission, 2011). As such, PRRC was initiated as an adaptive measure to climate change impacts. The application of PRRC and other crop rotation schemes started initially in the coastal communes and then spread towards central areas ten years ago. The diffusion in part also seems to be driven by the high economic values of prawn crops. The concept seems promising when the rotational crops not only could adapt to the disadvantageous hydrologic conditions but generate considerably higher income as well. However, then is it too good to be true? Indeed, our results have revealed different facets of PRRC. Significant variations in incurred costs, crop yields, and

crop selling prices for the An Minh district suggest that the PRRC is not necessarily the *golden goose* for everyone. The disparity is also reflected in the significant variance of ES economic values. The average value is 1300 USD/ha/year with a standard deviation of 600 USD/ha/year. These numbers disclose different situations of ES utilization efficiency. Besides farmers who have substantially converted ES into high economic values, there are others who have not yet adapted to the new cultivation scheme.

In particular, high yields, regardless of prawn or rice, could not guarantee substantial economic returns, for instance, in the Dong Hung B commune. Effectively managing associated costs and selling products at reasonable prices are of equal importance. These conditions could not be satisfied without sufficient practical experience, which apparently some households in the area are missing. Hence, sharing of practical experience within the community and between different communes should be encouraged to fill these knowledge gaps and to increase the overall values of provided ES (Scheyer *et al*., 2015). These goals could be achieved through local and regional seminars at which best practices and lessons learned from successful implementation could be presented and shared. For instance, the selection of crop seeds and sowing calendars, water quality and quantity standards, desalination methods, or agrochemical dosages, *etc.* are among essential information that could be shared to promote the success of PRRC in the region. Our findings also have showcased the need to integrate social attributes of the local community into land use planning besides natural conditions suitability.

3.5.5 Implications to Land Valuation

The application of ES evaluation framework could highlight the contribution of the ES to the local economy (Daily *et al.*, 2009; Primmer and Furman 2012; Hayha *et al*., 2015). We used Eq.1 adopted by the European Commission to calculate the economic values of this contribution by subtracting the investments from the human side. Hence, the economic value of ES was expressed as the input of Nature rather than just the marketed values of its end products, in particular, crop yields.

The non-negativity of ES values calculated gives the confidence of substantial input from the ecosystem to the local economy. Plus, this would point out that the effective assignment of land

prices might have underpriced the value of the area by not accounting for the values of incorporated ES on the land. The current land use policy places PRRC areas in the same category with other annual crops such as rice, vegetables, and values them based on geographical attributes (Kien Giang PPC, 2014). The simplification in classification and valuation of the valid land pricing codes would undervalue the roles of typical ES in each land uses, for instance, the seasonal hydrological conditions that facilitate PRRC. This bias is prone to underestimating the land values which might open doors to misconducts such as overexploitation of resources or inappropriate land use decisions. It is therefore recommended that the land evaluation code be re-visited to integrate the potential values of ES into the current pricing criteria and other land use management decisions. These aspects are explicitly addressed in Chapter 5 of this dissertation

3.5.6 Integration Ecosystem Services Framework into Land Use Planning

The integration of the ES framework has many advantages over the conventional approach. Firstly, it could reduce the conflicts between environmental concerns and economic objectives when the ecosystem is seen as a source of beneficial services that also bears economic values (Hayha *et al.*, 2015). Secondly, it offers a more holistic view of the current management through the benefits per unit land. The improvement, additionally, facilitates the comparison of other development proposals. Moreover, this standardization enables the aggregation to illustrate the spatial distribution of ES values in the area of interest, thereby facilitating communication of technical results to policy makers (Sumarga and Hein, 2014). Thirdly, the ES framework could be used to illustrate how various land use policies and management practices affect different stakeholders. In this research for instance, with the help of ES framework, we successfully revealed the divergence in readiness within the same community with regard to the application of PRRC. These two findings could shed useful light on the sensitivity of different stakeholders about land use changes that allows for the monitoring of the overall effects of land use policies as well as timely corrective actions (Sumarga and Hein, 2014, Scheyer *et al.*, 2015).

3.5.7 Risks and Challenges

A study conducted on the PRRC scheme in Ca Mau, a different province, but one that is also on Vietnam's Mekong Delta pointed to a number of risks and limitations of the PRRC practice.

Findings from this study showed the main problems in culturing prawn include water management, disease and breed quality whereas soil salinity, rice seed salinity adaptability, diseases and unfavorable weather conditions are major concerns in rice tillage. These difficulties, in fact, lie within the interrelated nature of the prawn and rice crops. The earlier prawn harvests in fact introduce the soil salinity. On the contrary, fertilizers, and agrochemicals left in the ground after the rice crops are among major reasons affecting the yields of the following prawn crops (Nguyen *et al*., 2011). On the other hand, PRRC could also be held responsible for a number of disservices such as the disruption of habitat and nursery function for wild animals or water resource pollution (Ma *et al*., 2015).

3.6 Conclusions

This case study presented an integrated approach to identifying, evaluate and map the associated ES with PRRC cultivation in which GIS played an important role throughout the process. The author found that the classification of satellite images using NDVI, MNDWI and ground points control could be a reliable technique to recognize PRRC areas in the context of coastal wetlands. Our research also shows the capacity of PCA and HCA in exploring the underlying structure of socio-economic data that can explain the variable economic performance of PRRC in the region. These methods are both more informative and capable of simplifying the interpretation of data structure as compared to conventional approaches.

This research adapted the ES framework to evaluate the application of PRRC in the west coast of Vietnam's Mekong Delta. Our findings confirm the suitability of PRRC yet expose some challenges. The latter relate to the divergence of living and farming experience in the community which, though subtle, have the capacity to disturb the efficiency of the cultivation scheme and cut back the values of ES eventually. Also, the current land pricing system is very likely to undervalue the land profitability by not considering the environmental benefits. In fact, the valuation decision was made predominantly on the geographical locations. This simplification might lead to the underestimation of negative impacts and rash land use decisions which would compromise the ecosystem health.

References

Atkinson, G., Bateman, I. and Mourato, S. 2012. Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy.* 28 (1), pp. 22 – 47.

Bartlett, M. S., 1937. Properties of sufficiency and statistical tests. Proceedings of the *Royal Statistical Society*, Series A 160, pp. 268–282.

BCS (Bayer Crop Science)., 2015. Positive impacts of Arize-BTE1 toward prawn cultivation in Prawn-Rice Rotational Crop areas in Bac Lieu, Ca Mau and Kien Giang. From: *http://www.cropscience.bayer.com.vn/vi-VN/News-Event-Program-Promotion/LuanCanhTomLua.aspx*

Boyd, J. and Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics.* 63, pp. 616 – 626.

Burkhard, B., Kroll, F., Nedkov, S. and Muller, F., 2011. Mapping ecosytem service supply, demand and budgets. *Ecological Indicators.* 21, pp. 17 – 29.

Chan, K.M.A., Satterfield, T. and Goldstein, J., 2012. Rethinking ecosytem services to better address and navigate cultural values. *Ecological Economics.* 74, pp. 8-18.

Congalton, R.S., 1991. A review of Assessing the Accuracy of Classifications of Remotely Sensed Data. *Remote Sensing Environment*. 37, pp. 35 – 46.

Costanza, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O7Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. and van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature.* 387, pp. 253 – 260.

Daily, G.C., 1997. Nature's Services. Island Press. Washington DC. USA.

Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: time to deliver. *Frontiers in Ecology and Environment.* 7. 21-28.

de Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C., ten Brink, P., van Beukering, P., 2012. Global estimates of the value of ecosytems and their services in monetary units. *Ecosytem Services.* 1, pp. 50 – 61.

European Commission (EC). Organization for Economic Co-operation and Development, United Nations, World Bank., 2013. System of Environmental-Economic Accounting 2012 – Experimental Ecosystem Accounting. United Nations, New York. USA.

Fagerholm, N. and Kayhko, N., 2009. Participatory mapping and geographical patterns of the social land scape values of rural communities in Zanzibar, Tanzania. *Fennia.* 187, pp. 43 – 60.

Farber, S., Costanza, R. and Wilson, M.A. 2002. Economic and ecological concepts for valuing ecosystem services. *Ecological Economics.* 41. 375 – 392.

Freeman, A.M., III. 2003. The Measurement of Environmental and Resources Values: Theory and Methods. 2nd edition. Resources for the Future. Washington DC.

Hadley, D., D'Hernoncourt, J., Franzen, F., Kinell, G., Soderqvist, T., Soutoukorva, A. and Brouwer, R.,2011. Monetary and non-monetary methods for ecosystem services valuation – Specific sheet and supporting material. *SPICOSA Project Report.* University of East Anglia. Norwich.

Hair, J. F., Anderson, R. E., Tatham, R. L., and Black, W. C. 1998. Multivariate Data Analysis, 5th edition. Upper Saddle River, NJ: Prentice-Hall.

Hayha, T., Franzese, P.P., Paletto, A. and Fath, B.D., 2015. Assessing, valuing, and mapping ecosystem services in Alpine forests. *Ecosystem Services.* 14, pp. 12-23.

Helian, L., Shilong, W., Guanglei, J., and Ling, Z. 2011. Changes in land use and ecosystem service values in Jinan, China. *Energy Procedia 5.* pp. 109-1115.

Husson, F., Josse,J. and Pages J. 2010. Principal component methods – hierarchical clustering – partitioning clustering: why would we need to choose for visualizing data. Applied Mathematics Department. Technical Report – Agrocampus.

Husson, F., Josse,J., Le,S. and Mazet, J.,2015. FactoMineR: Multivariate Exploratory Data Analysis and Data Mining. R package version 1.31.4. From: http://CRAN.R-project.org/package=FactoMineR

Kien Giang PPC (People's Committee)., 2014. Decision on land pricing code in Ken Giang province. *Decision*. No 35/2014/QD-UBND.

Kuenzer, C. and Tuan, V.Q. 2013. Assessing the ecosystem services value of Can Gio Mangrove Biosphere Reserve: Combining earth-observation and household survey-based analysis. *Applied Geography.* 45, pp. 167 – 184.

Le, S., Josse, J. and Husson, F., 2008. FactoMineR: An R Package for Multivariate Analysis. *Journal of Statistical Software*. 25(1), pp. 1-18.

Liu, S., Costanza, R., Troy, A., D'Aagostino, J. and Mates, W., 2010. Valuing New Jersey's ecosystem services and natural capital: a spatial explicit benefit transfer approach. *Environmental Management.* 45 (6), pp. 1271-1285.

Liu, S., Costanza, R., Farber, S. and Troy, A., 2010. Valuing ecosystem services. Theory, practice and the need for a transdisciplinary synthesis. *Ecological Economics Reviews.* Book Series: Annals of the New York Academy of Sciences. 1185, pp. 54 – 78.

Loomis, J., Kent, P., Strange, L., Fausch, K. and Covich, A., 2000. Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey. *Ecological Economics.* 33, pp. 103 – 117.

MA (Millennium Ecosystem Assessment)., 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington D.C. World Press Institute.

Ma, F., Eneji, A.E. and Liu, J. 2015. Assessment of ecosystem services and dis-services of an agro-ecosystem based on extended emergy framework: A case study of Luancheng County, North China. *Ecosystem services.* 82, pp. 241-251

Martín-López, B., Iniesta-Arandia, I., García-Llorente, M., Palomo, I., Casado-Arzuaga, I., Del Amo, D.G., Gómez-Baggethun, E., Oteros-Rozas, E., Palacios-Agundez, I., Willaarts, B., González, J.A., Santos-Martín, F., Onaindia, M., López-Santiago, C. and Montes, C., 2012. Uncovering ecosystem service bundles through social preference. *Plos ONE 7, e38970.*

Nguyen, C.T., Nguyen, V.H., Le X.S. and Dang, T.P. 2011. Analysis of risks and bottlenecks of rice-shrimp farming system currently practiced in Ca Mau peninsula. Conference proceedings. *National conference of aquaculture.* University of Forest and Aquaculture, Ho Chi Minh city, Vietnam.

Nicholson, S.E. and Farrar, T.J., 1994. The influence of Soil Type on the Relationships between NDVI, Rainfall and Soil Moisture in Semiarid Bostwana. I. NDVI Response to Rainfall. *Remote Sensing Environment*. 50, pp. 107 – 120.

Parida, B. R., B. Oinam, N. R. Patel, N. Sharma, R. Kandwal and M. K. Hazarika, 2008. Land surface temperature variation in relation to vegetation type using MODIS satellite data in Gujarat state of India. *International Journal of Remote Sensing*. 29, pp. 4219–4235.

Plieninger, T., Dijks, S., Oteros-Rozas, E. and Bieling, C., 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy.* 33, pp. 118-129.

Primmer, E., and Furman, E., 2012. Operationalizing ecosystem approaches for governance: do measuring, mapping and valuing integrate sector-specific knowledge systems? *Ecosystem Services.* 1, pp. 85 – 92.

R Core Team .2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. From: *https://www.R-project.org/.*

Remme, R.P., Schroter, M. and Lars Hein, L., 2014. Developing spatial biophysical accounting for multiple ecosystem services. *Ecosytem Services.* 10, pp. 6 – 18.

Richardson, L., Loomis, J., Kroeger, T. and Casey, F., 2015. The role of benefit transfer in ecosystem service valuation. *Ecological Economic.* 115, pp. 51 – 58.

Ryan, R.L., 2011. The social landscape of planning: integrating social and perceptual research with spatial planning information. *Landscape and Urban Planning* .100, *pp.* 361 – 363.

Schagner, J.P., Brander, L., Maes, J. and Hartje, V., 2013. Mapping ecosystem services's values: Current Practice and future prospects. *Ecosystem Services.* 4, pp. 33-46.

Scheyer, C., Gorg, C., Hauck, J.and Winkler. 2015. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. *Ecosystem services.* 16, pp. 174-181.

Seidl, R., Rammer, W., Jager, D., Currie, W.S. and Lexer, M.J., 2007. Assessing trade-offs between carbon sequestration and timber production within a framework of multi-purpose forestry in Austria. *Ecology Management.* 248, pp. 64 – 79.

Sumarga, E. and Hein, L., 2014. Mapping Ecosystem Services for Land Use Planning, the Case of Central Kalimantan. *Environmental Management.* 54, pp. 84 – 97.

Sumarga, E., Hein, L., Edens, B. and Suwarno, A., 2015. Mapping monetary values of ecosystem services in support of developing ecosystem accounts. *Ecosystem Services.* 12, pp. 71 – 83.

TEEB foundations. 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan. London and Washington D.C.

Teich, M. and Bebi, P., 2009. Evaluating the benefit avalanche protection forest with GIS-based risk analyses – a case study in Switzerland. *Forest Policy Management.* 257, pp. 1910 – 1919.

Troy, A. and Wilson, M.A., 2006. Mapping ecosystem services: practical challenges and opportunities in linking GIS and value transfer. *Ecological Economics.* 60(2), pp. 435-449.

Tuan, V.Q., Kuenzer, C. and Oppelt, N., 2015. How remote sensing supports mangrove ecosystem service valuation: A case study in Ca Mau Province, Vie Nam. *Ecosystem Services.* 14, pp. 67 – 75.

van Berkel, D.B. and Verburg, P.H., 2014. Spatial quantification and valuation of cultural ecosystem services in agricultural landscape. *Ecological Indicators.* 37, pp. 163 – 164.

Vietnam National Mekong Committee, 2011. Preliminary study on climate change adaptation plan in Kien Giang Province. Final Report.

Wilson, M.A. and Hoehn, J.P., 2006. Valuing environmental goods and services using benefit transfer: the state-of-the art and science. *Ecological Economics.* 60, pp. 335 – 342.

Xu, H., 2006. Modification of normalized difference water index (NDWI) to enhance open water features in remotely sensed imagery. *International Journal of Remote Sensing.* 27 (14), pp. 3025 – 3033.

Thi, T.H.N., De Bie, C.A.J.M., Smalling, E.M.A. and Thai, H.C. 2008. Mapping the irrigated rice cropping patterns of the Mekong delta, Vietnam, through hyper-temporal SPOT NDVI image analysis. International Journal of Remote Sensing. 33(2), pp. 415 – 434

Tabachnick, B. G. and Fidell, L. S. 2001. Principal components and factor analysis. In *using multivariate statistics* (4th ed., pp. 582–633). Needham Heights, MA: Allyn & Bacon.

Case Study No. 2

Development of Socio-geographical Indicators

CONTENTS

3.7 Introduction

In recent decades, the concept of Ecosystem Services (ES) has gained considerable attention as an operational approach to integrate the multiple contributions of nature, heretofore disregarded, into the decision-making process (Chan *et al*., 2012). Perhaps the most important contribution of ES framework is the multidisciplinary approach that necessarily combines science, social science, and engineering (Loc *et al*., submitted). The ES framework hence, takes a holistic approach to assign economic values to a full range of benefits derived from ecosystems, resulting in a compelling tool to convey environmental messages to a wider audience including landscape managers, policymakers, and the public. Although the integration of ecological and economic epistemologies plays a vital role in advancing ES knowledge (Turner and Daily, 2008), approaches of this kind cannot accommodate every dimension of ecosystems values as the term services itself cannot be defined without social considerations. While the inclusion of economic valuation brought in the ability to express some of the ecological values in more public friendly metrics, this effort also hinders the description of a full range of less tangible values, *e.g.*, cultural, educational, spiritual concerns, *etc.* that are more representative of "human behaviors". In essence, then, it is important to expand ES evaluation to fully embrace the three pillars of sustainable development; economy, society, and environment. Of course, in some cases we might consider a fourth pillar as Sahely *et al*., (2005) did; that of engineering.

The first challenge in accounting for these "human behaviors" relates to their vicissitudes among communities; hence, they are harder to measure through economic lenses. For instance, the capacity of an ecosystem to contribute to a given service, *e.g.*, recreation, tourism, or spirituality largely fluctuates across stakeholders' groups and so do their social demands across temporal and spatial scales (Daniel *et al*., 2012). These complexities of cultural values have been extensively documented in the historical or anthropogenic literature, and ecologists and ecological economists are increasingly adopting such considerations within ES analytical frameworks (Daniel *et al*., 2012). However, Carpenter *et al*., 2009 argued that evaluation techniques originally developed for these individually respective disciplines might not be sufficient to address the interrelated nature of ES, and underscored the need for transdisciplinary cooperation. Both additive and interrelating transdisciplinary approaches should not presume

any scientific primacies, sustaining a balance among alternative epistemologies to be successful in including the multiple types of knowledge (Pohl 2005).

Another barrier to the objective measurements of cultural values relates to how practitioners regard social aspects of ES within the analytical framework. Too often, services taxonomies treat cultural values as a broadly labeled, residual category after accounting for other utilitarian services. In fact, recreational, spiritual, education concerns, *etc.*, have distinctive characteristics within specific socioecological contexts and could be associated with important synergies or trade-offs. These imbalances are particularly meaningful to understand public attributes, needs, and expectations towards cultural benefits, thus better motivate support in the protection of ecosystems (Daniel *et al*., 2012). To better integrate these values we must consider some key questions: how can they be operationally defined? How can they be linked with ecological significances? Moreover, most importantly, how can we better classify and characterize relevant values and benefits?

To date, the integration of cultural services into the ES research remains weak, obstructing opportunities to further advance ES knowledge in decision and policy agendas. The objective of this paper, therefore, is to explore methods of assessing cultural services within the ES framework. More specifically, we aim to identify and evaluate the positive implications that a fuller taxonomy of spiritual and recreational ES could have in supporting sustainable tourism management. The case study presents an operational method to measure and represent a full list of intangible values using questionnaire-based and GIS-based indicators, paving the way to sound understanding of different benefits of seven renowned landscapes of Ha Tien Town in southwestern Vietnam.

3.8 The research area

The case study was performed at the historical town of Ha Tien and its surroundings, adjacent to the border with Cambodia in the north, Giang Thanh district in the East, Kien Luong district in the South, and the Gulf of Thailand in the West Sea along 22 kilometers of coastline. The town consists of four urban wards: To Chau, Phao Dai, Binh San, Dong Ho and two rural communes: My Duc and Thuan Yen, altogether cover the total area of 8,851 hectares (Fig. 3.8).

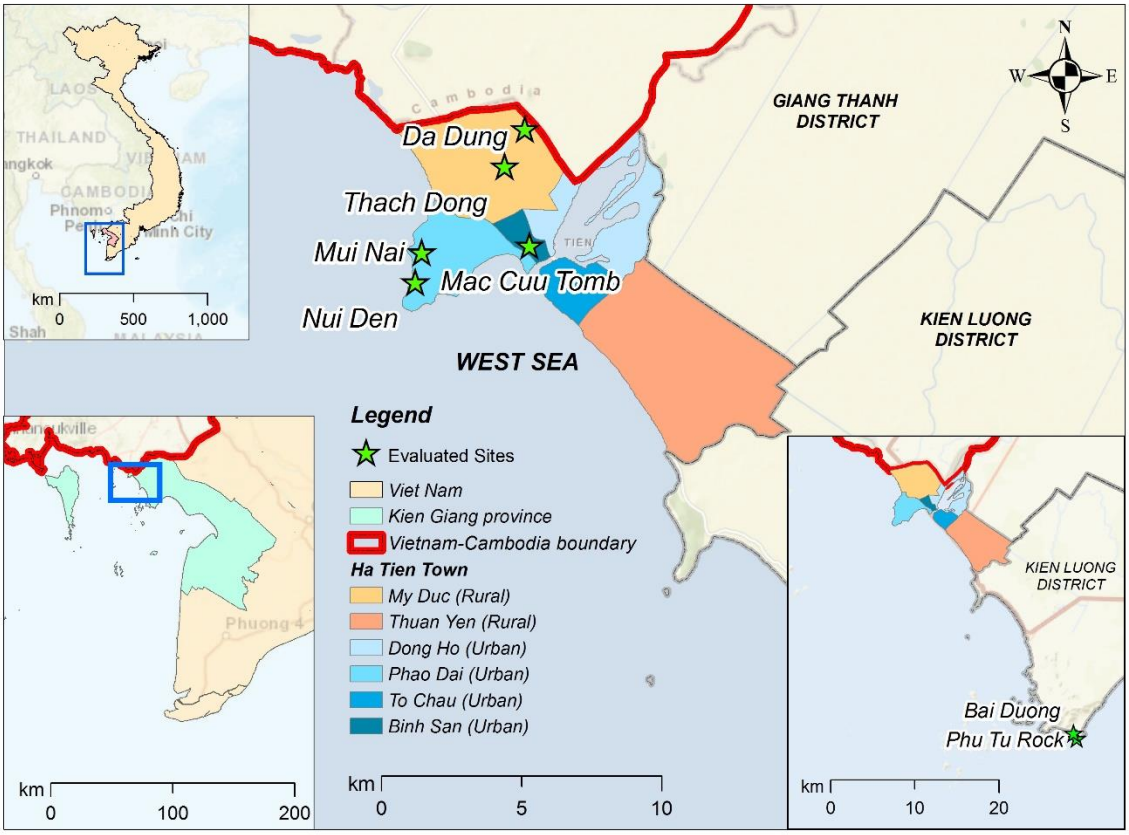
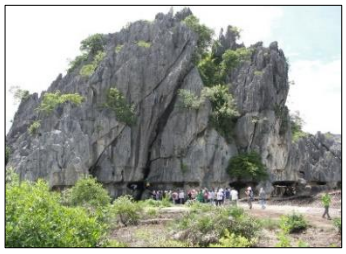


Fig. 3.8 Location of the Ha Tien Town and the evaluated landscapes

The study site is a narrow strip of coastal land with diversified topographies ranging from mountains, stone caves, beaches, to natural bays, many of which are nationally renowned for their scenic beauty. Within this research, associated Recreational ES and Spiritual ES of seven of the most notable scenic sites within the town periphery including Mui Nai, Nui Den, Thach Dong, Da Dung, and Mac Cuu Tomb. The list also included two farther sites *i.e.*, Phu Tu Rock, and Bai Duong located in the adjacent district of Kien Luong given their relevance to the regional tourism development strategy of Kien Giang (The European Union funded environmentally and socially responsible tourism capacity development Program, (EU-ESRT), 2015). Table 3.3 provides an overview.

Table 3.3 Evaluated landscapes

Sites	Location	Information
1. Mui Nai 	Phao Dai ward, 6 kilometers from Ha Tien downtown.	Mui Nai is among "ancient Ha Tien ten sceneries", famous for the mild and picturesque beaches of Bai Bang and Bai No. From 2008, the local government has invested significantly in the area, making it one of the most popular destinations for outdoor recreational activities such as team building, camping, *etc.*
2. Nui Den 	Phao Dai ward, one km from Mui Nai	Nui Den is a newly developed touristic destination of Ha Tien from 2009, well known for its scenic route and panoramic view from the mountain.
3. Thach Dong 	My Duc commune, 3 km from Ha Tien downtown.	Thach Dong is a colossal limestone mountain, related to one of the most popular Vietnamese folk tales. Inside is a wooden temple built in 1790, which was regionally popular for New Year Festival. Other attractions of the site include beautifully shaped stalactites and the scenic view extending towards Cambodia from the top of the cave.
4. Da Dung 	My Duc commune, close to Cambodia boundary.	Da Dung is a vertical limestone mountain, consisting of 14 interconnected caves. Da Dung used to be an important military base during several wars, thus classified as the National historical site.

5. Mac Cuu Tomb 	Binh San ward, in the center of Ha Tien	The history of Ha Tien is closely associated with Mac Cuu and his family who came from Quang Dong, China. Through 7 generations, people from Mac family had dedicated into making Ha Tien one of the busiest commercial ports during their times. The site was recognized as a National historical site in 1989
6. Phu Tu Rock  *Before 2006*  *Present day*	Binh An commune, Kien Luong district. 37 km from Ha Tien	Phu Tu (literately means father and son) rock is a twin rock, standing 5 meters above sea level. The shape of the rocks greatly resembled father and son closeness, hence the name. Phu Tu rock used to be the icon of Kien Giang sceneries until 2006 when the "father" rock collided.
7. Bai Duong 	Binh An commune, adjacent to Phu Tu Rock	Mild and sandy beach, adjacent to Phu Tu Rock. The site is popular for outdoor recreational activities such as school trips team building, swimming, *etc.*

3.9 Methodology

3.9.1 Research Design

Public Participation GIS

One approach to explore landscape cultural values is the *expertly facilitated deliberation* method (Gregory and Trousdale 2009; Daniel *et al*., 2012). In this research, the author sought to perform such an exercise through Public Participation GIS (PPGIS) that integrates community

collaborative activities with GIS to collect, analyze, and represent the stakeholders' perspectives (Fagerholm and Käyhkö 2009). The method refers to the concept of *volunteered geographical information* (Goodchild 2007) that has been widely used in urban planning and resource allocation associated research (Kingston *et al*., 2000; Craig *et al*., 2002). The real strength of this participatory approach lies in its ability to capture true local knowledge of the distribution of services, which are largely different from conventional mapping practices based on assumptions adopted from the literature (Fagerholm *et al*., 2012). In a developing context, the concept of PPGIS is commonly associated with the use of GIS to engage stakeholders in decision-making under collaborative planning (Brown and Reed 2009; Craig *et al*., 2002). During a PPGIS exercise, there are several options for participants to express their spatial knowledge, including delineating sites using pencils or markers; or locating sites on provided maps or aerial photographs using color-coded stickers; or labeling features on maps with pre-identified landmarks (McIntyre *et al*., 2004; Brown and Reed 2009; Plieninger *et al*., 2013). For this case study, the last technique was chosen given the comparative convenience during the surveys and the simplified tasks in the subsequent spatial analysis processes.

Evaluation Indicators

One of the most critical decisions during this initial stage of research relates to the choice of appropriate benchmarks to evaluate the landscapes and the associated values. Within the literature, perhaps the predominant valuation index is monetary value, which could be due to the generally held belief that unless monetized, the benefits derived from ecosystems will be ignored (Wainger and Mazzotta, 2011). The problematic part of this approach is that ES are predominantly common goods that are shared, rather than owned and thus lack necessary market prices as reliable signals for valuations (Daniel *et al*., 2012). Even with marketable objects, such as revenues from tourism activities; it is still questionable whether the estimates as such are sufficiently robust as they may overlook the local features (Stoll-kleemann 2001). As such, the evaluations of some services still remain elusive, for instance, regional identity or sense of place (Butler, 2006). The search for reliable accounting systems for landscape cultural values is also confronted by the diversity in distribution flows. In particular, some values are passively

delivered to beneficiaries, *e.g.*, aesthetics, spirituality, while others require human inputs, *e.g.*, angling, camping, (Villamagna *et al*., 2014; Daniel *et al*., 2012). The flows of ES, therefore are difficult to generalize across communities and this presents critically challenge to economic assessments (MA 2005; Daniel *et al*., 2012).

As a contribution to addressing these difficulties, and to functionalize the assessment of landscape non-utilitarian values, we propose the use of three independent indicators, including (1) the richness of ES, (2) self-declared quantitative evaluations of associated ES, and (3) Willingness to travel (WTT). The characteristics of these estimation methods are summarized in **Table 3.4**.

Table 3.4 Evaluation Indicators

Indicators	Estimation methods	Units
Richness of RES	The total amount of RES nominations associated with each site	Entries
Quality of RES	For each nominated (dis) services, respondents were asked to describe their preferences using the 5 level Likert scale, in which 1 through 5 represents ascendance satisfactory or concern, respectively	Scaled points
WTT	1. We first estimate the actual travel distances between respondents' households and each site using Origin-Destination (OD) Matrix within the Network Analyst package of ArcGIS Version 10.4. 2. We quantified the information regarding how often respondents travel to each site for recreational purposes. 3. The multiplication of the resulting matrix of the previous steps results in the ultimate WTT matrix.	Distances

3.9.2 Selected Ecosystem (Dis) services

The exercise to classify relevant RES and SES began with the categories proposed by MA, 2005 and the list of cultural benefits evaluated by the existing literature (Fagerholm and Käyhkö, 2009; Plieninger *et al*. 2013). The author also referred to specific taxonomies of cultural ES such as those in Daniel *et al*., 2012; Chan *et al*., 2012. However, most of these publications are associated with more developed contexts, hence several mentioned services are either not available, *e.g.*, horse riding, hunting, gathering wild food, or hunting, or not relevant, *e.g.*, dog walking or cycling. Also, it was found that the definitions of some benefits are relatively similar, *e.g.*, existence *versus* identity, spiritual *versus* inspiration, and thus difficult to distinguish. On the other hand, we

identified several site-typical ES such as camping, enjoying seafood, or ritual interactions, *etc*. After performing the questionnaire pretest, the final list of services to be evaluated includeds three spiritual values: *Aesthetics*, *Spiritual*, and *Relaxation;* and five recreational activities: *Walking, Swimming, Angling, Enjoying seafood*, and *Camping*. The questionnaire also investigates five adverse aspects, denoted as Ecosystem Disservices (EDS): *Uncleanliness, Unreasonable prices, Crowdedness, Noisiness*, and *Security* (**Table 2).**

Table 3.5 Definitions of Selected Services and Disservices

SES and Disservices	Definition as understood within the scope of this research
Aesthetics	Areas with natural scenery
Ritual interactions	Areas of religious importance
Relaxation	Areas that can stimulate relaxing feeling for physical and mental recovery
Uncleanliness	Areas that are of unhygienic concern (pollutions, garbage, *etc.*)
Unreasonable prices	Areas where managed services feel overpriced
Crowdedness	Areas that are disturbingly crowded
Noisiness	Areas that are disturbingly noisy
Insecurity	Areas that feel dangerous

One of the most problematic issues during the ES related social surveys relates to the communication about highly technical terms to participants. Following the suggestions by Plieninger *et al*. (2013), we made efforts to simplify the language of the questionnaire. In particular, to gather information about the location of sites with significant *Ritual Interactions* values, we asked: "Among these places, where do you often visit for praying or worshiping." The fundamental idea is to facilitate lay people understanding within the context of their living experiences. As such, we strove to harvest true place-based knowledge, paving the way for active exploration of local insights regarding recreational and spiritual values.

3.9.3 Household Surveys

The targeted populations for this research were the residents of Ha Tien town. Face-to-face interviews was chosen over other self-administered methods given the higher response rates (Whittington *et al*., 1990). The first draft of the questionnaire was put on a pretest in July 2016 at these field sites, through which, difficulties, particularly focusing on whether the individual

questions were understandable were analyzed. Regarding the interactions with participants, residents in rural communes, specifically in Thuan Yen commune are relatively harder to approach. These people are mainly ethnically Teochew people, having migrated over centuries from Eastern Guangdong province in China. As such, their responses are particularly relevant to help understand the perception diversity among social groups. Ultimately, a local field assistant had to be invited to help to familiarize our interviewers with the inhabitants to conduct the surveys, under the condition that no personal information would be disclosed afterward. The survey was finally finished in three weeks from September 2nd - 20th 2016.

The interviews started with the introduction about the purposes of the study. The interviewers then explained, in general, about the importance of ecosystems and the benefits they provide to humans, emphasizing the spiritual and recreational aspects. The discussions extended to topics relevant to respondents' preferences about the local landscapes (in **Table 1)** and their associated values. Finally, we collected respondents' social background information, *i.e.*, gender, age groups, and occupations. Typical interviews took approximately 40 to 50 minutes to finish. To facilitate the subsequent spatial analysis process, locations of every respondents' households were georeferenced using handheld GPS devices.

3.9.4 Data Analyses

For the household survey, a total of 123 questionnaires, equally distributed across the research area were collected. Our sample size is comparable to the current ES evaluation and mapping research using community-scale interviews, *e.g.*, Plieninger *et al*., (2013); Raymond *et al*., (2009); Fagerholm *et al*., (2012); or Loc *et al*., (2016). This case study utilizes ArcGIS 10.4 for spatial analyses, and R for statistical analyses (Le *et al*., 2008; Husson *et al*., 2015; R Core Team 2015).

Statistical Analyses

To explore the spatial correlations between pairs of (dis-) services, the author utilized Spearman's rank correlation coefficient (ρ). Additionally, Correspondence Analysis (CA) was applied to explore the bundles of (dis-) services nominations across different landscapes. With respect to the assessment of the social dimension, the author aimed at investigating the underlying structure among respondents' perceptions towards different services through

Principal Component Analysis (PCA) and Hierarchy Cluster Analysis (HCA). The collected data adequacy was verified by Bartlett's Test for Homogeneity of Variances (Bartlett 1937) and Kaiser-Meyer-Okin Measure of Sampling Adequacy (Tabachnik and Fidell 2001). Regarding the consistency of principal components, the Kaiser criterion was used (Hair *et al*., 1998).

Spatial Analyses

Prior to the analysis, it was relevant to assume the means of transportation were solely motorcycles, given their prevalence in the study site. Our estimation of shortest distances between each respondents' household and seven evaluated sites follows the flowchart depicted in Fig. 3.9.

In the initial stage, spatial data depicting the existing transportation system of Ha Tien area was obtained through OpenStreetMap (Haklay and Weber, 2008; OpenStreetMap Contributors, 2015). Subsequently, Google Earth was used to locate the seven evaluated landscapes. After finishing the interviews, the locations of each respondent's household were digitized and exported into ESRI shapefiles. In the second stage, a functional "road network" modelled was developed using Network Analyst extension. The developed model also incorporates additional information such as crossroads, turns, one-way roads, and restricted areas, needed for the solution of shortest routes. Next, other relevant spatial data, including the boundary of the area, locations of relevant landscapes, and respondents' households were also imported into the model.

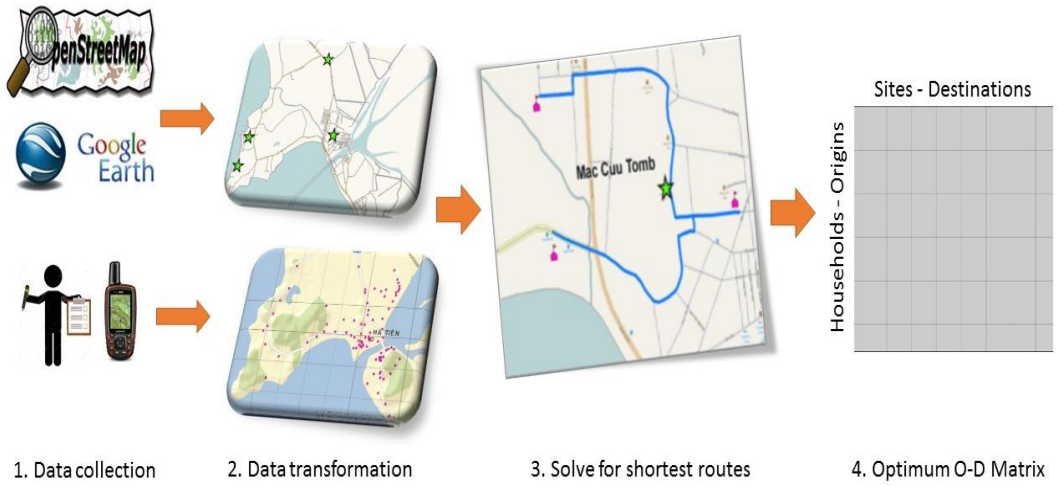


Fig. 3.9 Spatial Analysis for Optimum Routes

In the third stage, optimum routes between two random points were solved for to validate the constructed road network model. The third figure in Fig. 3.9 shows examples of the shortest possible routes between three respondents' households and Mac Cuu Tomb as solved by Network Analyst. After validating the network model, the author performed the OD Matrix Analysis to solve for all optimum routes for each respondent in traveling from his or her household to every associated sites. The resulting matrix consists of 861 optimum routes connecting 123 georeferenced respondents' households and seven relevant landscapes.

3.10 Results

3.10.1 Characteristics of Respondents

Within 123 individual questionnaires collected, males and females accounted for 52 % and 48 %, respectively. Regarding the age groups, 48 persons are under 30 years old; 35 persons are between ages 31 and 39; 20 persons are between ages 40 and 49, and 20 persons are above age 50. Regarding the Occupations, 55 respondents were running their businesses such as small restaurants or grocery shops; the rest include 13 farmers, ten public officials, eight students, 19 self-employed, *e.g.*, caregivers, and 18 of other professions

3.10.2 Services and Disservices

The nominations

Among three SES examined, *Aesthetics* is the most predominant (n = 198), followed by *Spiritual Interactions* and *Relaxation* values. With respect to RES, *Walking* is perceived the most (n = 120). Other recreational activities, *i.e., Swimming, Enjoying Seafood, Camping*, and *Angling* accounted for 88, 64, 53, and 40 entries, respectively. The total EDS nominations are approximately half of that if ES with 387 entries. Among which, *Uncleanliness* is the most popular concern (n= 105), followed by *Unreasonable Prices* and *Insecurity* with 93 and 80 entries, respectively. Lastly, *Noisiness* and *Crowdedness* were respectively nominated 55 and 54 times (Fig. 3.10).

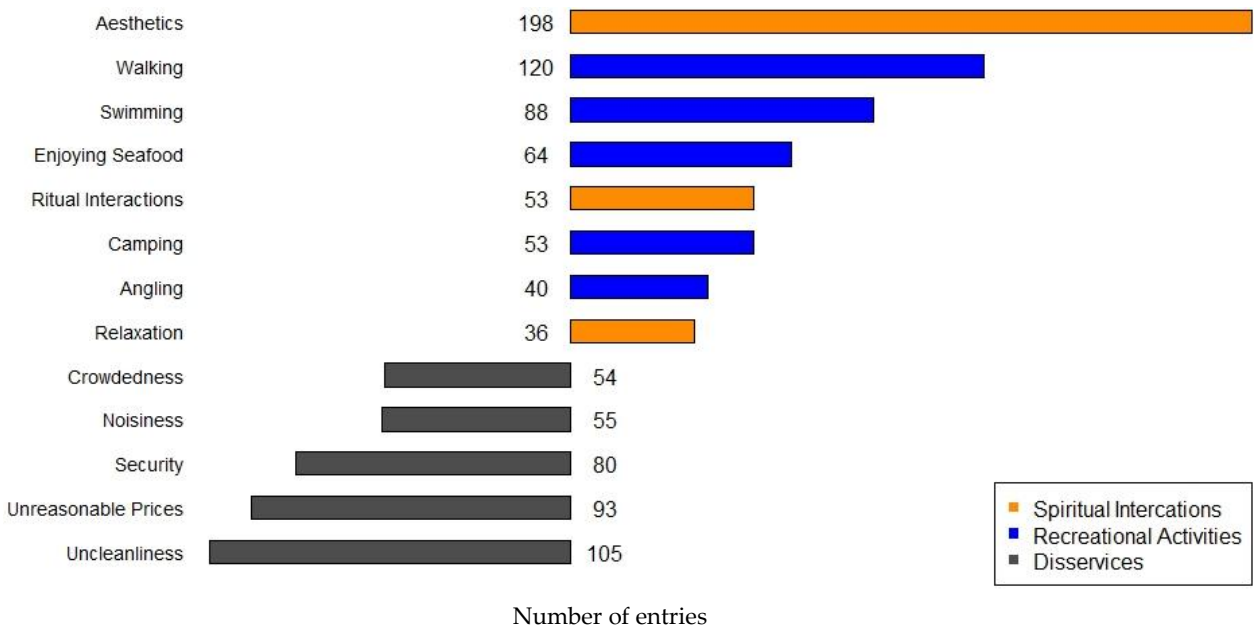


Fig. 3.10 Services and Disservices nominations

Spatial Correlations

Results from Spearman's rank correlation analysis (Table 3.6) highlighted that among SES, *Aesthetics* was the benefits with the strongest positive correlations, both to other services: *Walking* (0.93) and disservices: *Uncleanliness* (0.75), and *Unreasonable Prices* (0.68). With respect to RES, *Camping* is the activity with the highest number of strong and medium correlations. Regarding Disservices, the strongest correlated one is *Security,* followed by *Unreasonable Prices, Noisiness,* and *Crowdedness.* In addition, this EDS is the strongest negative correlated with *Camping* (-0.92) and *Angling* (-0.86), implying that feeling safe is an essential requirement to enjoy these two benefits.

Table 3.6 Spatial correlations between pairs of (dis) services

(Dis) services	1	2	3	4	5	6	7	8	9	10	11	12
1. Aesthetics	1.00											
2. Ritual Interactions	-0.11	1.00										
3. Relaxation	0.35	-0.65	1.00									
4. Walking	0.93	-0.30	0.39	1.00								
5. Swimming	0.27	-0.65	0.88**	0.40	1.00							
6. Angling	0.33	-0.86**	0.58	0.57*	0.74**	1.00						
7. Enjoying Seafood	0.16	-0.55	0.73**	0.20	0.88**	0.58*	1.00					
8. Camping	0.26	-0.85**	0.49	0.44	0.69*	0.94**	0.70*	1.00				

9. Uncleanliness	0.75**	-0.33	0.33	0.89**	0.53*	0.67*	0.43	0.63*	1.00			
10. Unreasonable Prices	0.68*	-0.15	0.57*	0.68*	0.67*	0.35	0.67*	0.37	0.79**	1.00		
11. Crowdedness	0.38	0.17	0.46	0.40	0.61*	0.17	0.46	0.06	0.47	0.71**	1.00	
12. Noisiness	0.33	0.15	0.36	0.38	0.61*	0.24	0.51	0.17	0.55*	0.71**	0.97**	1.00
13. Security	-0.04	0.96**	-0.55*	-0.22	-0.65	-0.86**	-0.65	-0.92	-0.37	-0.19	0.17	0.09

Gray shading indicates medium positive correlation (0.5 < ρ < 0.7), dark gray indicates strong positive correlations (ρ > 0.7)

4.2.3. Relationships to respondents' perceptions

The sampling data was verified using the Kaiser-Meyer-Okin equals 0.77 (> 0.5) and the Bartlett's Test of Sphericity (ρ < 0.05), thereby supporting the performance of factor analysis methods. The first three principal components (dimensions or axes) of PCA account for 69.44 % of extracted variance (Fig. 3.11). In particular, the first axis (42.35% of total extracted variance) is positively correlated with two SES *i.e., Aesthetics* and *Relaxation;* and three RES *i.e., Walking, Enjoying Seafood,* and *Camping.* The second axis (14.45 % of total extracted variance) is positively related to *Angling.* Lastly, the third axis (12.63 % of total extracted variance) is strongly correlated with *Ritual Interactions.* In general, respondents' evaluations regarding relevant ES are closely connected and positively correlated with the exceptions of Angling and Ritual Interactions.

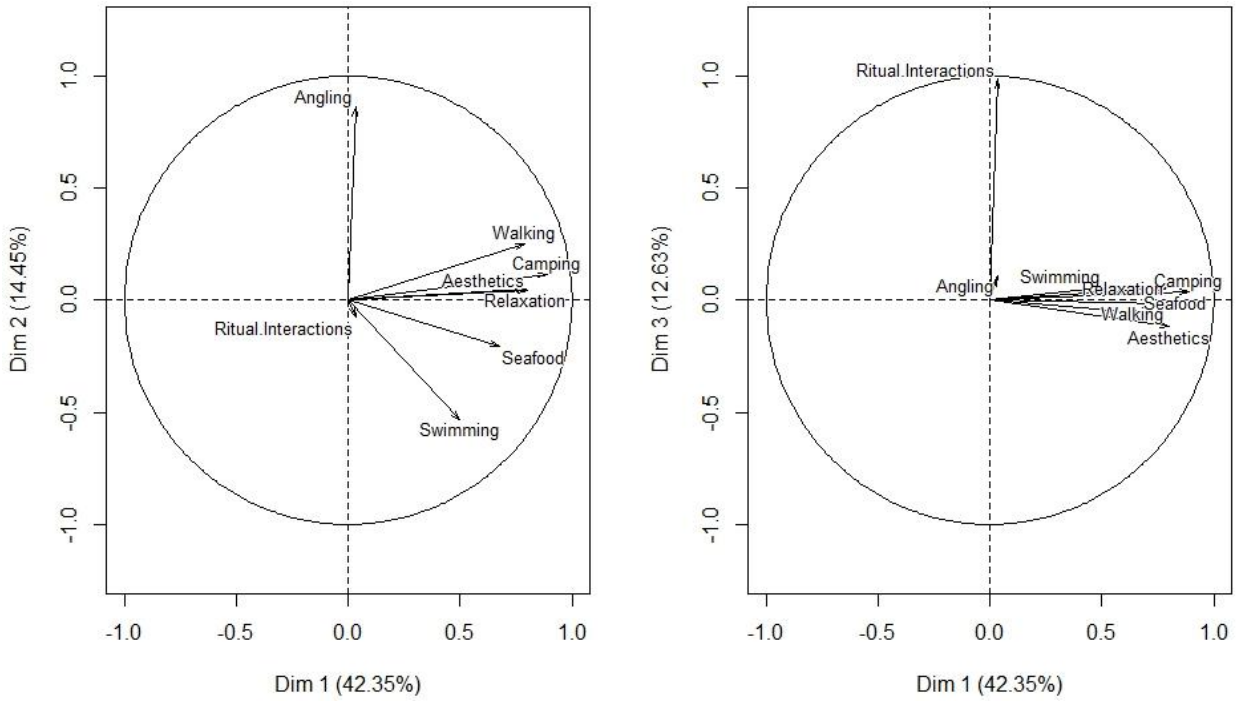


Fig. 3.11 PCA Factor Map of Primary Variables

The subsequent analysis includes the exploration of the bundles among respondents' perceptions in accordance with their social background through Hierarchical Cluster Analysis (HCA). Utilizing the factor map of individuals (n = 123) generated from PCA, six groups (or clusters) of individual responses with distinct attributes were detected of which their attributes were summarized in Table 3.7**.**

With respect to three spiritual values considered, *Aesthetics* is the highest regarded with 7.45, followed by *Ritual Interactions* with 2.25 and *Relaxation* with 1.07. Regarding relevant recreational activities, *Walking* is the highest with 4.36, followed by *Swimming, Enjoying Seafood, Camping,* and *Angling* with 2.74, 2.07, 1.39, and 1.02, respectively. Among the social categorical variables included, respondents' *household locations* are the most significantly correlated, followed by *Occupations* and *Age*. Fig. 3.12 projects the spatial distributions of six clusters on the factor maps of HCA.

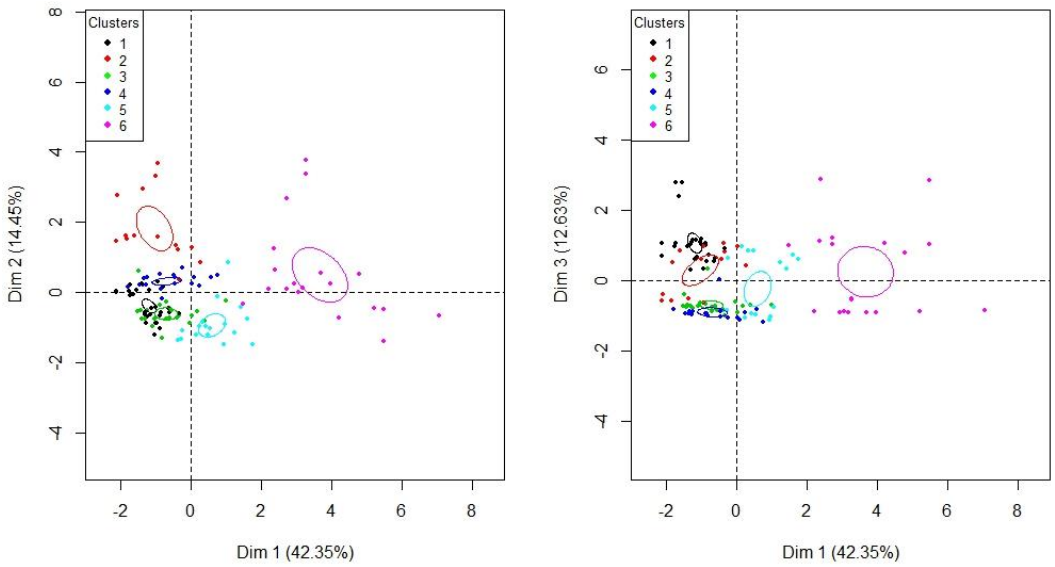


Fig. 3.12 Clustered Factor Map of Individuals

From the representation of evaluating variables and individuals, it was found that **t**he first principal component (Dim 1) distinguishes two clusters 5 and 6, those with the highest regards for *Aesthetics, Relaxation, Walking, Enjoying Seafood,* and *Camping* with the others. With respect to social attributes, these Clusters mostly consist of respondents from Phao Dai and Dong Ho districts. The second principal component (Dim 2) could highlight the individual cloud of Cluster

2 who typically enjoy *Angling.* What makes *Angling* such a prominent RES might relate to the requirements of typical equipment, making it more like a professional sport than casual recreational activities such as *Swimming* or *Walking*. Similarly, the third principal component (Dim 3) clearly separates individuals with different perceptions towards *Ritual Interactions* value, suggesting fundamental differences between this SES and other recreation-based spiritual values. In particular, Cluster 1 consists of respondents from To Chau district with the highest regard, which is largely in contrast to the perceptions of respondents from My Duc and Thuan Yen communes who made up Clusters 3 and 4. It is also important to mention that the majority of Thuan Yen residents are made up by Teochew community that was referred to in Section 3.3.

Table 3.7 Characteristics of Clusters explored by HCA

Variables	Overall mean of Population	p-value	Mean of Clusters					
			1	2	3	4	5	6
Spiritual Values								
Aesthetics	7.45	7.98×10^{-18}	4.08	4.78	5.17	NA(*)	9.66	14.47
Ritual Interactions	2.25	1.25×10^{-15}	5.14	NA	0.125	0.15	NA	NA
Relaxation	1.07	1.06×10^{-20}	NA	NA	NA	NA	0.17	4.69
Recreational Activities								
Walking	4.36	3.79×10^{-17}	2.11	NA	2.08	NA	NA	11.52
Swimming	2.74	3.37×10^{-17}	NA	1.00	4.17	NA	4.44	4.26
Enjoying Seafood	2.07	1.47×10^{-22}	0.43	NA	0.5	NA	5.72	4.36
Camping	1.39	1.63×10^{-52}	NA	NA	NA	NA	NA	8.63
Angling	1.02	1.01×10^{-17}	NA	4.17	NA	NA	NA	NA
Social attributes								
Household Locations			To Chau	Phao Dai	My Duc	Thuan Yen	Dong Ho	Phao Dai
Occupations			NA	Others	NA	NA	NA	NA
Age			NA	NA	51 - 59	Elder	NA	NA

Notes: Green and Red shades depict higher and lower points compared to the Population, respectively

3.10.3 Evaluation Indicators

The Richness of associated ES

Depicted in Fig. 3.13 is the summary of the entry number of (dis) services associated with each site. In general, Mui Nai has the most associated ES with 332 entries, within which recreational activities account for the majority of 229 entries, more than double of spiritual values with 103 entries. Other sites with a similar predominance of RES include Nui Den and Bai Duong. Meanwhile, a site with the second highest intensities of ES, Thach Dong (n=223) is more associated with spiritual values through 81 entries, compared to 22 entries of recreational activities. Mac Cuu Tomb and Da Dung also have relatively similar ratios between spiritual and recreational benefits, though with far fewer entries. With respect to the incurring negative experiences, Thach Dong and Mui Nai also have the highest intensities with 183 and 120 entries of EDS, respectively; followed by Bai Duong and Mac Cuu Tomb, both with 21 entries.

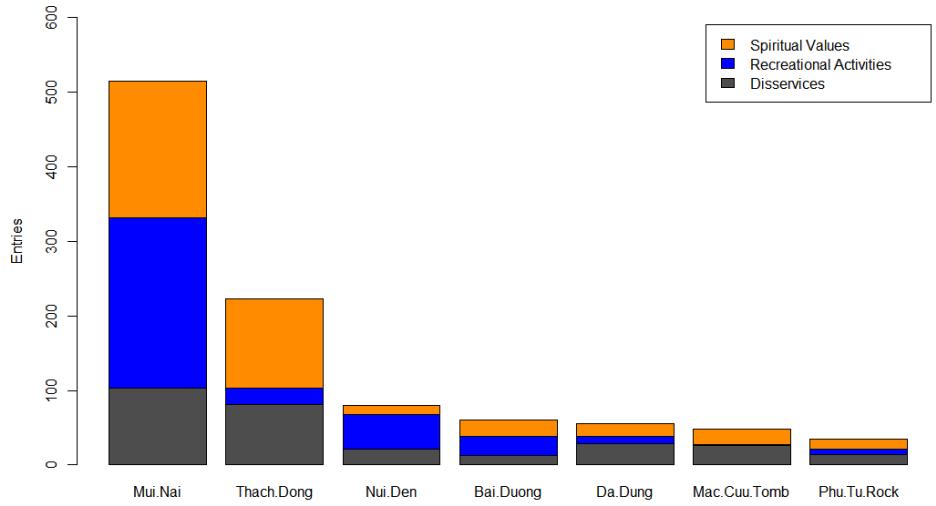


Fig. 3.13 Services and Disservices intensities of different sites

The bundles among RES, EDS as well as the linkages between these (dis) services across the evaluated sites were further detected through CA results. Based on the contingency matrix of different benefits (*i.e.*, SES, RES, and EDS as rows) across relevant sites of evaluation (as columns), bundles between ES flows and landscapes were projected in Fig. 3.14. The first two principal components accounted for 86.57 % of the extracted variances of the entire data. The first principal

component (64.67 % of extracted variance) differentiates the bundles of SES and EDS whereas the second component (21.90 % of extracted variance) separates the bundles of RES.

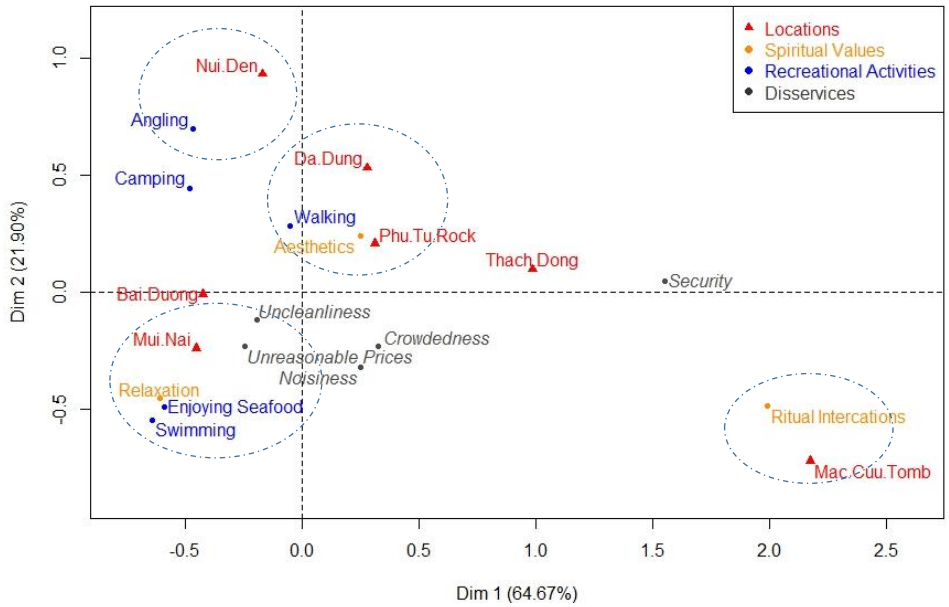
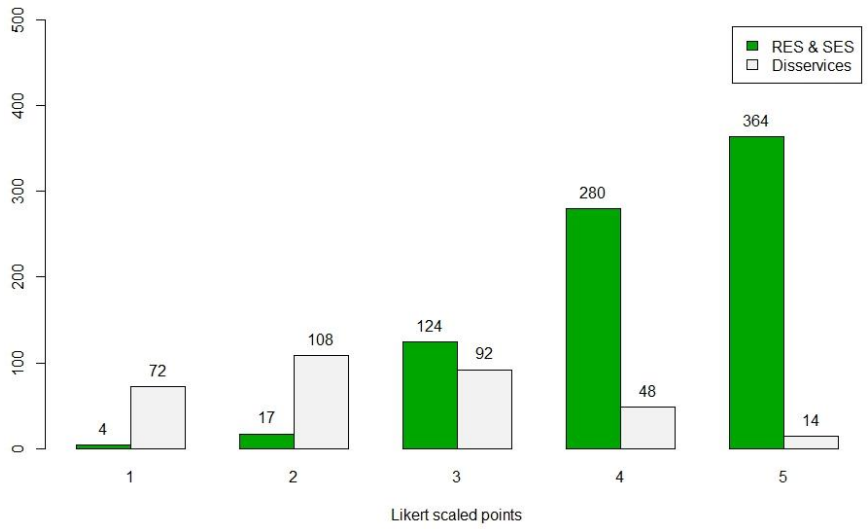


Fig. 3.14 Bundles between RES and the landscapes

Highlighted spiritual values related bundles include: (1) *Ritual Interactions* being the most associated with Mac Cuu Tomb; (2) *Aesthetics* being the most associated Phu Tu Rock and Da Dung; and (3) *Relaxation* being the most associated with Mui Nai. Among associated recreational activities, (1) *Angling* is the most associated with Nui Den, (2) *Walking* is the equally associated with both Da Dung and Phu Tu Rock, whereas (3) *Enjoying Seafood* and *Swimming* are predominantly related to Mui Nai. Of equal note are the demonstrated associations among ES flows such as (i) the bundle among *Relaxation, Enjoying Seafood,* and *Swimming;* and (ii) the bundle between *Walking* and *Aesthetics* suggest substantial relevance among these benefits. For instance, visitors to Mui Nai or Bai Duong could enjoy seafood, swimming, both of which could stimulate their feelings of relaxation. Likewise, the Aesthetics landscapes could greatly enhance walking experiences. Finally, with respect to EDS, the concern of *Security* is more associated with Thach Dong and Mac Cuu Tomb, whereas respondents are likely to criticize Mui Nai and Bai Duong for their *Unreasonable Prices* and *Uncleanliness.* The two remaining EDS, *i.e., Crowdedness* and *Noisiness* are not typical for any sites.

The quality of associated ES

Throughout the survey, participants showed far higher regards to RES benefits than the concern of EDS. In particular, as visualized in Fig 3.15**,** moving from 1 through 5, the number of ES related responses substantially increases, whereas the Disservices curve exhibits a peak at 2 points (n= 108) before gradually subsiding. The table integrated underneath the figures provides significance descriptions of the utilized Likert scales.



Types	Likert Scales Descriptions				
	1	2	3	4	5
RES & SES	Strongly dissatisfied	Relatively dissatisfied	Neutral	Relatively satisfied	Strongly satisfied
Disservices	Strongly relevant	Relatively relevant	Neutral	Relatively irrelevant	Strongly irrelevant

Fig. 3.15 Histogram represents the respondents' evaluations

The self-declared judgments of respondents greatly diversify across different sites as depicted in Fig. 3.16 A. Regarding relevant ES, Mac Cuu Tomb is the highest valued sites with the average score of 4.806, followed by Thach Dong with 4.485. On the contrary, Mui Nai, albeit the highest intensity of associated ES is the second lowest with the average point of 4.131, only marginally higher than Phu Tu Rock with 3.974. Essentially, those who recognized landscapes' spiritual are more likely to rank these benefits higher than the recreational based ones. The average scores of EDS in Fig. 3.16 B are relatively lower than those of services regardless of the sites. In particular, respondents are the most concerned about Nui Den and Phu Tu Rock with 3.25 and 3.00,

respectively. The second group of sites with marginal differences includes Da Dung, Mac Cuu Tomb, Mui Nai, and Thach Dong with average scores of 2.625, 2.545, 2.46, and 2.322. Bai Duong is the "best" site in this regard with the average EDS score of 1.81.

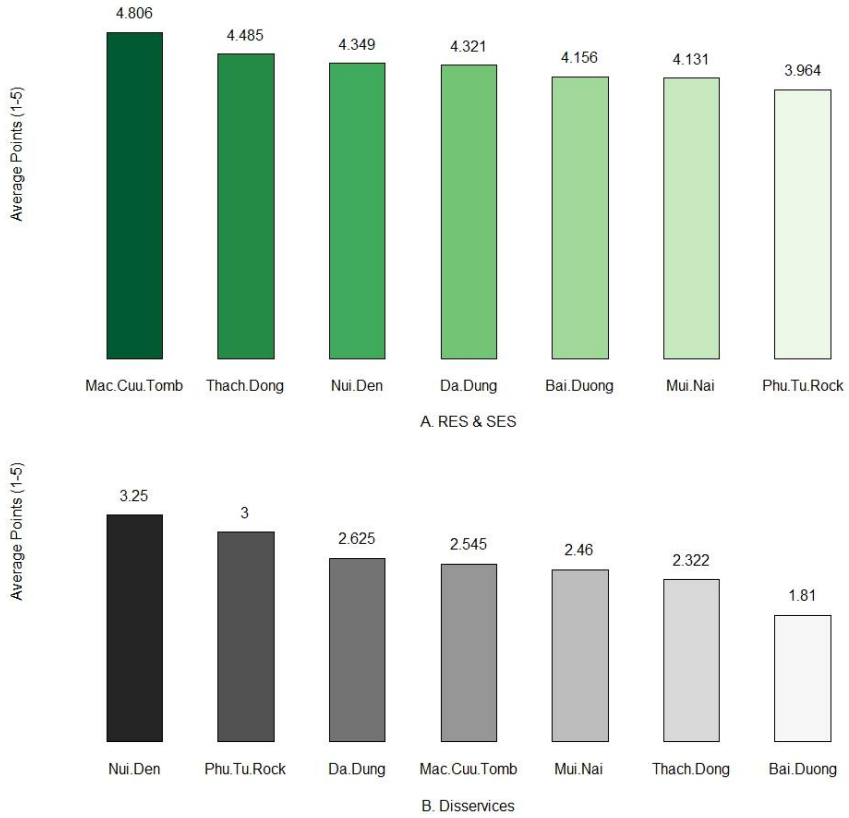


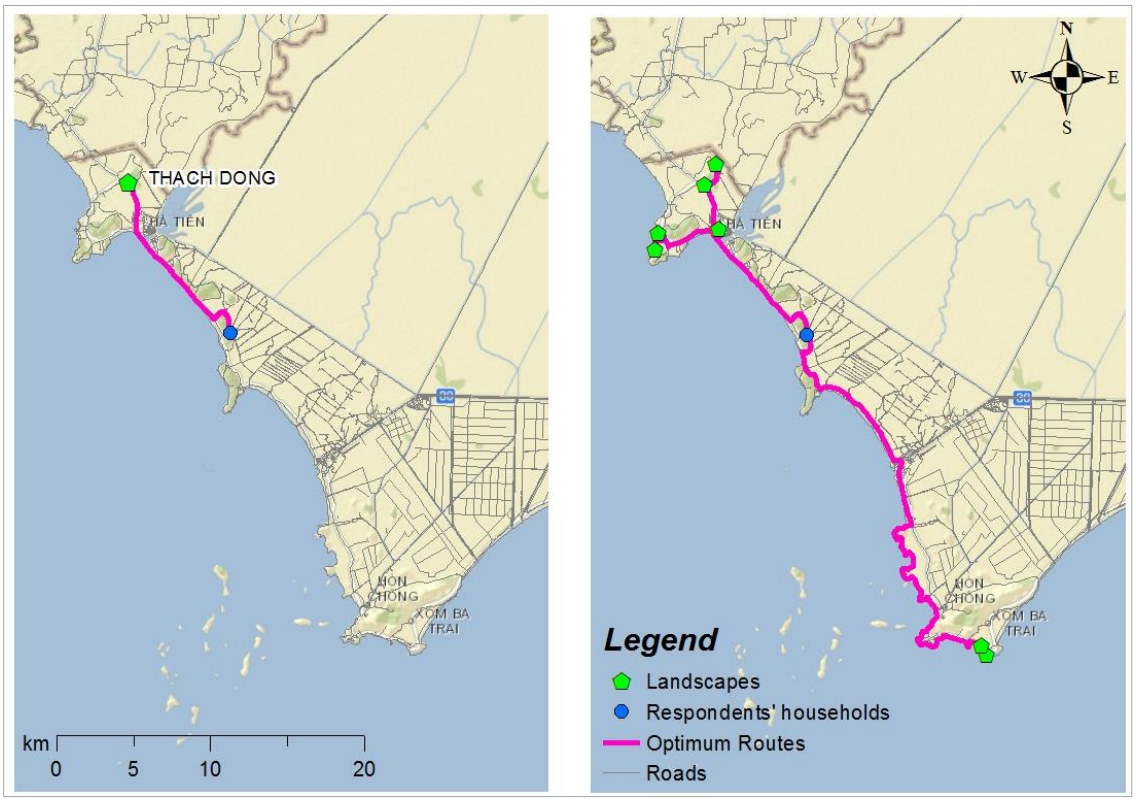
Fig. 3.16 Landscape qualities as perceived through associated (dis) services

Willingness to Travel (WTT)

A. Calculation of optimum travel routes

The optimum travel courses between each respondents' households to each site was calculated using the OD Matrix tool within the Network Analyst extension of ArcGIS as exemplified in Fig. 3.16. In which, Fig. 3.17 A shows an example optimum route from a respondent's household to Thach Dong whereas Fig 3.17 B shows similar solutions to all evaluated sites. The integrated table underneath the figures summarizes the geographical length of the optimum routes of this example solved by the OD Matrix analysis. By the end of this process, the lengths of 861 such optimum routes between 123 households of respondents and 7 relevant sites were calculated.

The resulting matrix (hereinafter referred as The Optimum Routes (OR) Matrix) essentially represents the travel costs potentially incurred for each respondent in visiting each site.



(A) **(B)**

Optimum Travel Distances (kilometers)						
Mui Nai	Nui Den	Da Dung	Thach Dong	Mac Cuu Tomb	Bai Duong	Phu Tu Rock
14.448	14.908	14.625	13.334	10.447	35.301	36.063

Fig. 3.17 Analysis of Optimum Routes between respondents' households and recreational sites.

B. Frequency of Visits

The frequency and intensity of usage are the important signals in assessing recreation and tourism services (Daniel *et al*., 2012). Within this case study, respondents might choose from three alternatives: *"None"*, *"Rarely"*, and *"Usually"* to represent the frequency of their visits to each site for recreational purposes. These responses were then into zero, 0.5, and 1, respectively. The resulting matrix (hereinafter referred as the Travel Frequency (TF) Matrix) as summarized in Fig. 3.18 highlights Mui Nai and Thach Dong as the most commonly visited destinations, followed by

Nui Den, Mac Cuu Tomb, Da Dung, Phu Tu Rock, and Bai Duong. These evaluation results are generally consistent with the assessment of ES richness previously presented, inferring demonstrated correlations between the two indicators.

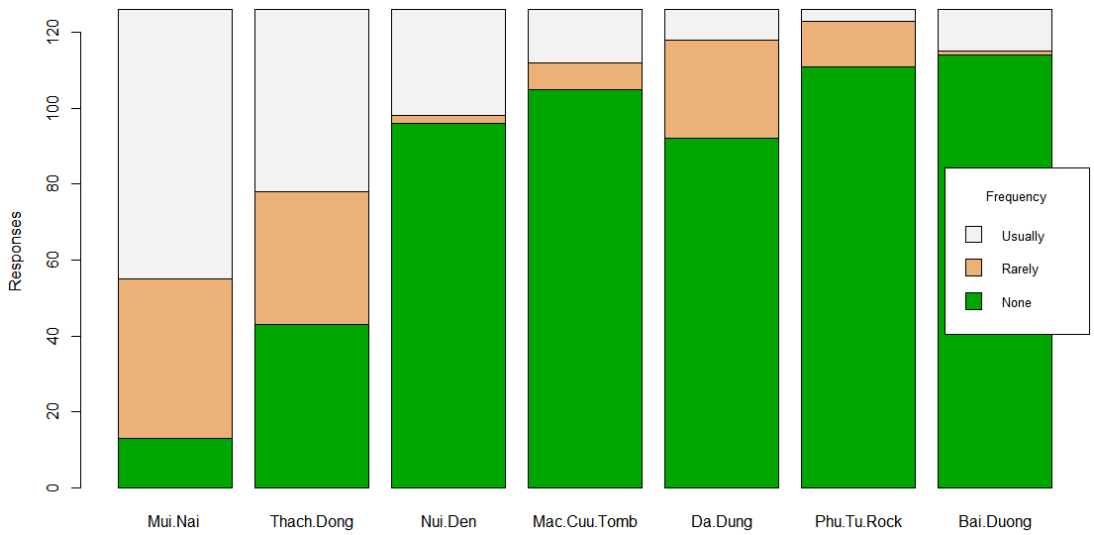


Fig. 3.18 Respondents' recreational traveling preferences

C. Willingness to Travel

Finally, the multiplication of OR with TF matrixes resulted in the final WTT matrix, comprehensively representing respondents' traveling preferences towards each evaluated site as shown in Fig. 3.19. In this regard, Mui Nai can draw the most WTT with 569.750 kilometers that largely agrees with the site highest intensities of associated recreational activities. In the same manner, the site with the richest SES values, Thach Dong can attract 344.74 kilometers of WTT, making it the third highest among seven sites examined.

With respect to the farthest sites, *i.e.*, Bai Duong and Phu Tu Rock, despite their insignificance in ES richness, can essentially draw respondents' preferences, making them the second and fourth highest in the WTT evaluation histogram. The inconsistency between ES richness and WTT evaluations in this case, partly due to the relatively distant locations of these two sites, but also implicates the role of intrinsic values that potentially enhances the utility in traveling to these sites to specific respondents. On the contrary, at the lowest end of the assessment spectrum is the Mac Cuu Tomb, of which the WTT is smaller compared to other sites. The low WTT this historical

tomb, mainly due to the limited recreational opportunities on the one hand, also signifies the majority of neighboring communities among visitors' population on the other.

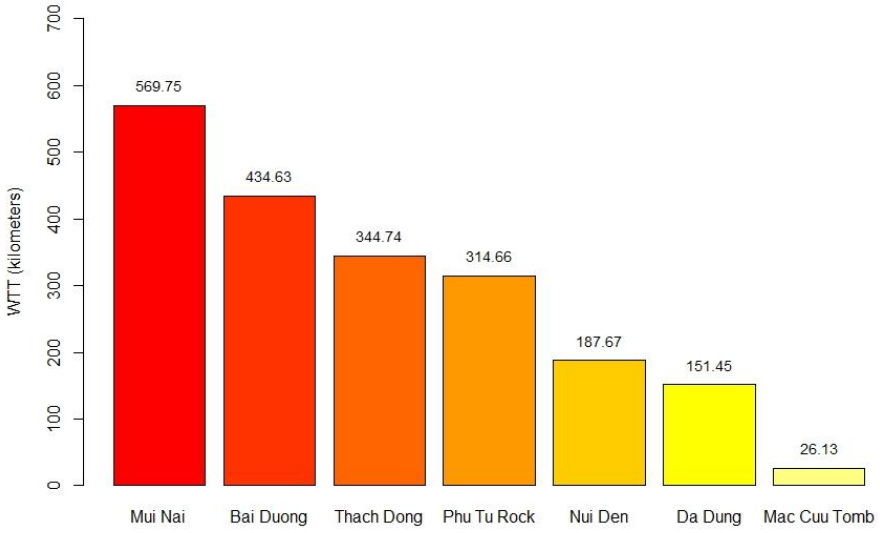


Fig. 3.19 Total Willingness to Travel

D. Spatial Patterns of WTT

To have a deeper understanding of the geographic patterns of respondents' travel preferences; a spatial interpolation assessment that combines Optimized Hotspot Analyses (OHA) and Inverse Distance Weighted (IDW) was conducted. More specifically, WTT matrix was spatially joined into the point layer of the respondents' households. OHA was then conducted to statistically verify the spatial differences of WTT among the individuals, depicted by maps of distributing Hot Spots and Cold Spots. Finally, a spatial interpolation using IDW technique was conducted to visualize the WTT spatial distribution of each associated site (Fig 3.20).

In line with the previous assessments, warm colors extending across the particular figure of Mui Nai signifies its major attractiveness for both surrounding and farther communities. The adjoining site, Nui Den, however, can only draw substantial WTT among its neighborhoods and relatively inconsistent preferences from the outer edges. Major disparities in terms of associated recreational activities could help explain the different WTT spatial patterns between these two nearby ecotourism resorts. In particular, while Mui Nai offers visitors a full range of leisure activities, recognized RES of Nui Den only include *Walking, Angling,* and *Camping*, each of which

with far fewer entries. However, lower intensities of perceived benefits might not necessarily lead to restricted WTT, particularly in the case of sites with spiritual significances such as Thach Dong, Da Dung, Bai Duong, and Phu Tu Rock. None of these three sites is significant in ES richness, however can substantially attract distant visitors thus suggests important intrinsic values people attach to the specific landscapes exceeding the ES-based assessment framework. With specific regard to *Ritual Interactions* value, Thach Dong, and the Mac Cuu Tomb are the most associated sites through 30 and 20 entries, respectively. However, respondents also resonate the attractions of the first with *Aesthetics* value through 51 entries, making it more like a scenic landscape, which explains the extended WTT map towards distant communities. On the contrary, Mac Cuu Tomb is solely associated with *Ritual Interaction,* making it less meaningful for distant visits.

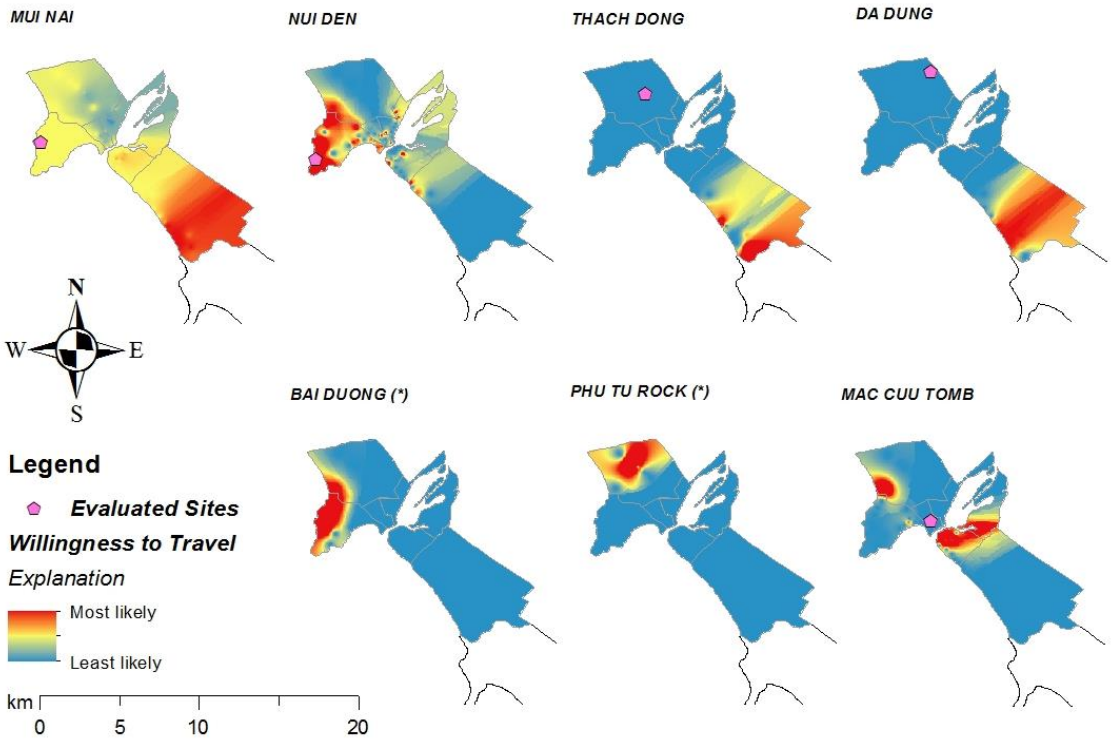


Fig. 3.20 Spatial distribution of WTT of each destination

(*) Bai Duong and Phu Tu Rock are outside Ha Tien town periphery; hence, their locations are missing.

3.11 Discussions

3.11.1 Social-based accounts of landscape qualities

This case study aimed to bring forth an operational method to capture and represent a range of spiritual values and recreational opportunities that people perceive and enjoy at the community level. The findings confirm demonstrated correlations between diverse benefits derived from multiple local sites with respondents' individual well-being. Among the list of evaluated services, *Aesthetics* and *Ritual Interactions* are the most recognized SES, whereas *Walking* and *Swimming* are the most important RES. These observations deeply resonate with the characteristics of the evaluated landscapes, which highlights the functionality of the presented method in measuring landscape qualities through associated spiritual and recreational benefits. Given the drawbacks of economic approaches in accounting for less utilitarian values, the use of alternative indicators could be of particular relevance to balance assessments of material and non-material services in landscapes inhabited and utilized by people (Chan *et al*., 2012). Moreover, the study was able to document the structural linkages between groups of respondents with specific local sites without significant declared ES intensities that point to the existence of other intrinsic values such as communal ties, or cultural heritage (Plieninger *et al*., 2013).

With respect to EDS, most referred to the negative effects from human uses, not directly emerged from the ecosystems itself, except for *Security* that was associated with possible accidents, *e.g.*, falling from cliffs. These observations largely agree with Agbenyega *et al*., (2009) and Plieninger *et al*., (2013), who both took note on the potential use of EDS to indicate overuses of RES. In this case, the associations between relevant anthropogenic disservices with eco-tourism resorts are signs of degradations due to overexploitation and misconducts of relevant beneficiaries.

3.11.2 Measures of landscape values

There is an increasing interest in the exploration of cultural values and their attributes in natural resources conservation, as reflected in their inclusion in the ES classification of MA (2005). Largely different from utilitarian benefits, cultural values seldom generalize across communities; hence, they are generally more difficult to measure through economic lenses. For instance, the

capacity to contribute to a given service, *e.g.*, recreation, tourism or spirituality usually fluctuates across stakeholders' groups and so do their temporal, social demands. Therefore, efforts at a monetary valuation of these services appear to be absent; regardless of their contributions recognized by researchers and policy makers (Daniel *et al*., 2012). In the associated body of literature, stated-preference results such as Willingness to Pay (WTP) or Willingness to Accept (WTA) are metrics often employed to estimate ES non-use values (MA, 2005). These indexes, however, are subject to fundamental biases and, in particular within developing contexts, struggles of respondents in grasping the notion of hypothetical markets of natural resources presents a major challenge (Whittington, 1998).

Within this research, the author sought to introduce an alternative measure of landscape qualities. The geographical indicator, WTT integrates questionnaire-based information about the frequency of site visits for recreational purposes with GIS-based measurement of respective traveling efforts. Two important implications of this method lie in first, the freely available data from OpenStreetMap, and the objective, bias free measurement of respondents' valuations towards cultural landscapes. Results from the WTT can indicate different aspects of landscape qualities, supporting other findings in representing the values of landscapes as perceived by people. One of such is the correlations between spiritual values and recreational activities. For instance, Mui Nai has the highest ES richness and WTT, which explains its popularity as a tourism destination. In contrast, the ritual significance of the Mac Cuu Tomb is not so meaningful to distant communities as it is to the neighbors. The inconsistencies between WTT and RES richness of Phu Tu Rock and Bai Duong take notes on important intrinsic values of landscapes, extending beyond the utilitarian services framed in the questionnaire. These unquantified values might be related to heritage, legacy, or communal cultural ties shared across generations (Stephenson, 2008). Unfortunately, the limited sample size of this case study would not enable any bold conclusions in this regard.

3.11.3 Perception bundles

Results from this case study expand on previous observations of Hagerhall, (2001) concerning the consensus in the appreciation of natural beauty and casual recreational activities. People

perceive the aesthetics of landscapes and a sense of relaxation through walking, swimming, and enjoying seafood in a relatively homogeneous manner, mostly irrespective of their social backgrounds. Among the categorical variables included in the analysis that represents respondents social attributes, only household locations were significantly related to the separation among groups of participants. In line with Soini *et al*., (2012), the author observed that awareness and familiarity are decisive variables for landscape perception. For instance, the inhabitants living closer to Mui Nai are more likely to express higher regards for the associated RES and SES. Another example relates to the perceptual differences towards *Ritual Interactions* value of the Mac Cuu Tomb and Thach Dong between nearby and distant communities.

Results of Spearman's Rank correlations and PCA detect considerable overlap among evaluated services, both activity based and spiritual based, for instance the demonstrated synergies among *Relaxation, Enjoying seafood,* and *Swimming* or among *Aesthetics, Walking,* and *Camping,* pointing to the interconnected nature of cultural services (Daniel *et al*., 2012; Plieninger *et al*., 2013). In addition, the PCA variable factor map also detects the disparities of *Ritual Interactions* and *Angling* from other services, as reflected by the exclusive correlations with separate principal components. The separation of *Ritual Interaction* from the overall bundle of evaluated services resonate deeply with previous insights from (Stamps, 1999) concerning the diversified preferences towards spiritually modified sites. Results from HCA confirms that adjacent residents are more likely to appreciate the spiritual significance of Mac Cuu Tomb and Thach Dong, which is largely different from the perceptions of the Teochew community living in Thuan Yen. Among the list of RES evaluated, *Angling* is the most outstanding, which suggests the need of fuller characterization of landscape recreational benefits, especially between casual activities, *e.g.*, swimming, walking, *etc.* versus those requiring additional investments.

Of equal importance is the detected bundles between ES and EDS, in particular, those associated with the managed eco-tourism sites, which essentially resembles the two sides of a coin. Conservationists often recognize recreational and tourism activities as threats to ecosystems via, *e.g.*, disturbance of wildlife, habitat (Reed and Merenlender, 2008). These benefits, however, offer excellent chances for people to experience clearly the benefits of ES by enhancing physical

and physiological well-being. The positive implications of recreational services, therefore, represent pedagogical opportunities concerning human-nature nexuses and the protection of ecosystems (Daniel *et al*., 2012).

3.11.4 Implications for tourism management

This case study expands on previous findings of Fagerholm *et al*., 2012; Plieninger *et al*., 2013; and Van Berkel and Verburg, 2014 regarding the structural relationships between cultural ES and local landscapes. In particular, it was observed that people do not randomly assign SES and RES, but rather in structural patterns, leading to the appearance of hot spots and cold spots across the evaluated landscapes. Independent indicators can then be utilized to measure these different aspects of spiritual and recreational values, paving the way to the function wise prioritization of local landscapes.

The results also confirm the demonstrated correlations between (dis) services and landscape properties. In particular, Mui Nai is the most relevant to *Relaxation* through recreational activities of *Swimming* and *Enjoying Seafood*, but have the highest level of *Uncleanliness,* all of which are related to the intended function of the site as a tourism resort. Though closely located, Nui Den is considerably *colder* given its limited choice of recreational activities as perceived by respondents. Mac Cuu Tomb and Thach Dong are particularly meaningful to experience *Ritual Interactions* but are commonly concerned about *Security* concern. Other sites were much less associated with any SES or RES. These findings confirm previous conclusions from the Vietnam National Administration of Tourism regarding key challenges in the tourism development of the area being the lack of meaningful activities for long stay visits (EU-ESRT, 2015).

Cultural landscapes, as well as the goods and services derived, may represent a whole region, and act as important trademarks for touristic offers and product marketing (Tempesta *et al*., 2010). For effective policy and decision-making, it is important to identify specific ecologically based landscape features that are associated with the particular cultural values of stakeholders in a given cultural context (Chan *et al*., 2012). Hence, detected linkages between cultural values to physical landscape features are necessary to improve recreational experiences without having to compromise important ecosystems and cultural identities. These implications contribute

meaningful inputs to the sustainable development of tourism product of the region (EU-ESRT, 2015).

3.11.5 Ways Forward

In addressing one of the key questions raised within the ES community "*How can we understand the diverse benefits depending on the diversity of beneficiaries of RES?*" this study was able to detect and represent such perception divergences within the evaluated community of Ha Tien. However, the study site also serves significant flows of outside visitors, including classic tourists, religious travelers, *etc.* whose perceptions are not likely to be either homogenous or similar to the locals'. For instance, classic tourists coming Western countries often look for symbolic landscapes, temples, or native recreational activities. Religious travelers, on the other hand, are mainly domestic coming from nearby provinces, are the most interested in worshipping a specific temple such as the Mac Cuu Tomb, and typically not interested in other activities. Chances are good that associated tourism activities might coincide or conflict with the religious or spiritual use of the landscapes such as the Golden Pavilion in Kyoto, Japan or the pilgrimage route to Santiago de Compostela in Spain (Nolan and Nolan, 1992). Therefore, thorough assessments for both outside visitors and aboriginal residents are important to enhance tourism product quality while respecting local situations, needs, and expectations (Daniel *et al*., 2012).

Some other important implications for future research relates to the use of WTT for the representation of landscape qualities. Within developing country rural context of this study, in which the motorcycle is the predominant means of transportation, the search for optimum routes is comparatively straight forward, *i.e.,* the shortest drivable distance. Nevertheless, the method can accommodate far more complicated settings, such as simulating connections different means of public transportation: subways, trains, ferries, *etc.* In such complex models, tickets, travel time, or traffic conditions, *etc.* and other money relevant parameters such as can be incorporated into the analysis, constituting a holistic, reliable representation of respondents' perceptions towards evaluated landscape, especially those associated with recreation and tourism (Daniel *et al*., 2012).

3.12 Conclusions

Ecosystems often support multiple services, and the negotiations of tradeoffs and synergies among services might not be possible in case some services are unknown or ignored, which is usually applicable cultural ES. Therefore, many tradeoffs are still decided based on assumptions, thus ignoring potential synergies as well (Rodríguez *et al*., 2006). In this chapter, the author sought to address this lack of references with thorough quantification, and assessment of relevant services and disservices.

Using a self-developed list of relevant benefits, this case study detects fundamental differences between ritual values and recreation activities based values. These important observations confirm the limitations of the popular classification systems of ES regarding the lumping of distinctive benefits under one label being cultural services. In other words, fuller taxonomies of definitions, characterizations, as well as appropriate approaches are essential to integrate the less utilitarian components of ES into the overall analytical framework (Daniel *et al*., 2012; Chan *et al*., 2012)

With respect to the evaluation methods, the combination of questionnaire-based survey with geographic analysis tools has enabled the exploration of the social and spatial aspects of various non-use landscape services. In particular, the author found that social-based aggregation indices such as ES richness and ES qualities are meaningful metrics for cultural landscape assessments. Besides, they constitute convenience inputs for statistical methods to visualize the diversity of responses in a structural manner. The results, as such, could convey explicit messages about the different perspectives towards the diverse benefits derived from landscapes, and the linkages in between.

Additionally, from the spatial data available from OpenStreetMap, the author was able to include respondents' WTT as the third benchmark. Geographical representation of WTT pointed to the diversity in destination preferences among different communities, which consolidate findings from social-based indicators. Given the demonstrated positive implications of WTT method and the capacity of GIS in spatial analyses, the method potentials is not likely to be fully explored. Besides the prevalent, yet controversial indicators, *e.g.*, Willingness to Pay or

Willingness to Accept, practitioners could also make use of WTT to perform objective evaluations of the cultural landscape and their associated ES.

References

Agbenyega, O., Burgess, P.J., Cook, M., Morris, J., 2009. Application of an ecosystem function framework to perceptions of community woodlands. *Land Use Policy*. 26, pp. 551–557.

Brown, G.G., Reed, P., 2009. Public participation GIS: A new method for use in national forest planning. *Forest Science*. 55, pp. 166–182.

Butler, C.D., and Oluoch-Kosura, W., 2006. Ecology and Society: Linking Future Ecosystem Services and Future Human Well-being. *Ecology and Society*. 11 (1), pp. 30 - 46

Carpenter, S.R., Mooney, H.A., Agard, J., Capistrano, D., Defries, R.S., Díaz, S., Dietz, T., Duraiappah, A.K., Oteng-Yeboah, A., Pereira, H.M., Perrings, C., Reid, W. V, Sarukhan, J., Scholes, R.J., Whyte, A., 2009. Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment. *Proceedings of National Academy of Science. U. S. A*. 106, pp. 1305–1312.

Chan, K.M.A., Satterfield, T. and Goldstein, J., 2012. Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics*. 74, pp. 8–18.

Craig, W.J., Harris, T.M. and Weiner, D. (Eds.), 2002. Community Participation and Geo- graphic Information Systems. Taylor & Francis, London.

Daniel, T.C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J.W., Chan, K.M. a., Costanza, R., Elmqvist, T., Flint, C.G., Gobster, P.H., Gret-Regamey, A., Lave, R., Muhar, S., Penker, M., Ribe, R.G., Schauppenlehner, T., Sikor, T., Soloviy, I., Spierenburg, M., Taczanowska, K., Tam, J., von der Dunk, A., 2012. Contributions of cultural services to the ecosystem services agenda. *Proceedings of National Academy of Science*. 109, pp. 8812–8819.

EU-ESRT: The European Union funded environmentally and socially responsible tourism capacity development Program, 2015. Tourism product development of three Mekong Delta provinces: An Giang, Can Tho and Kien Giang. Program No. DCI-ASIE/2010/21662. Technical Report.

Fagerholm, N. and Käyhkö, N., 2009. Participatory mapping and geographical patterns of the social landscape values of rural communities in Zanzibar, Tanzania. *Fennia*. 187, pp. 43–60.

Fagerholm, N., Käyhkö, N., Ndumbaro, F. and Khamis, M., 2012. Community stakeholders' knowledge in landscape assessments - Mapping indicators for landscape services. *Ecological Indicators*. 18, pp. 421–433.

Goodchild, M.F., 2007. Citizens as sensors: The world of volunteered geography. *Geo Journal* 69, pp. 211–221.

Gregory, R. and Trousdale, W., 2009. Compensating aboriginal cultural losses: An alternative approach to assessing environmental damages. *Journal of Environmental Management*. 90, pp. 2469–2479.

Hair, J. F., Anderson, R. E., Tatham, R. L., and Black, W. C. 1998. Multivariate Data Analysis, 5th edition. Upper Saddle River, NJ: Prentice-Hall.

Haklay, M., Weber, P., 2008. OpenStreet map: User-generated street maps. *IEEE Pervasive Computing*. 7, pp. 12–18.

Husson, F., Josse,J., Le,S. and Mazet, J.,2015. FactoMineR: Multivariate Exploratory Data Analysis and Data Mining. R package version 1.31.4. From: http://CRAN.R-project.org/package=FactoMineR

Kingston, R., Carver, S., Evans, A. and Turton, I., 2000. Web-based public participation geographical information systems: An aid to local environmental decision-making. *Computers, Environment and Urban Systems*. 24, pp. 109–125.

Le, S., Josse, J. and Husson, F., 2008. FactoMineR: An R Package for Multivariate Analysis. *Journal of Statistical Software*. 25(1), pp. 1-18.

Loc, H.H., Diep, N.T. hong, Can, N.T., Irvine, K.N. and Shimizu, Y., 2016 (In Press). Integrated evaluation of Ecosystem Services in Prawn-Rice rotational crops, Vietnam. *Ecosystem Services*.

MA (Millennium Ecosystem Assessment). 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington D.C. World Press Institute.

McIntyre, N., Yuan, M., Payne, R.J. and Moore, J., 2004. Development of a values-based approach to managing recreation on Canadian Crown lands. *Working Papers of the Finnish Forest Research Institute*, 2, pp. 285–293.

Nolan, M.L. and Nolan, S., 1992. Religious sites as tourism attractions in Europe. *Annals of Tourism Research*. 19, pp. 68–78.

OpenStreetMap contributors, 2015. Planet dump [Data file from December 20th 2016] retrieved from http://planet.openstreetmap.org

Plieninger, T., Dijks, S., Oteros-Rozas, E. and Bieling, C., 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy* 33, pp. 118–129.

Pohl, C., 2005. Transdisciplinary collaboration in environmental research. *Futures* 37, pp. 1159–1178.

R Core Team .2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. From: https://www.R-project.org/.

Raymond, C.M., Bryan, B.A., MacDonald, D.H., Cast, A., Strathearn, S., Grandgirard, A., Kalivas, T., 2009. Mapping community values for natural capital and ecosystem services. *Ecological Economics*. 68, pp. 1301–1315.

Reed, S.E., Merenlender, A.M., 2008. Quiet, Non consumptive Recreation Reduces Protected Area Effectiveness. *Conservation Letters*. xx, pp. 1–9.

Rodríguez, J.P., Beard, T.D.J., Bennett, E.M., Cumming, G.S., Cork, S., Agard, J., Dobson, A.P., Peterson, G.D., 2006. Trade-offs across space, time, and ecosystem services. *Ecology and Society*. 11, pp. 28.

Soini, K., Vaarala, H., Pouta, E., 2012. Residents' sense of place and landscape perceptions at the rural-urban interface. *Landscape and Urban Planning*. 104, pp. 124–134.

Stamps, A.E., 1999. Demographic Effects in Environmental Aesthetics: A Meta-Analysis. *Journal of Planning Literature*. 14, pp. 155–175.

Stephenson, J., 2008. The Cultural Values Model: An integrated approach to values in landscapes. *Landscape and Urban Planning*. 84, pp. 127–139.

Stoll-kleemann, S., 2001. Reconciling opposition to protected areas management in Europe: the German experience. *Environment: Science and Policy Sustainable Development*. 43, pp. 32–44.

Tabachnick, B. G., and Fidell, L. S. 2001. Principal components and factor analysis. In Using Multivariate Statistics (4th ed., pp. 582–633). Needham Heights, MA: Allyn & Bacon.

Tempesta, T., Giancristofaro, R.A., Corain, L., Salmaso, L., Tomasi, D., Boatto, V., 2010. The importance of landscape in wine quality perception: An integrated approach using choice-based conjoint analysis and combination-based permutation tests. *Food Quality and Preference*. 21, pp. 827–836.

Turner, R.K., Daily, G.C., 2008. The ecosystem services framework and natural capital conservation. *Environmental and Resources Economics*. 39, pp. 25–35.

Van Berkel, D.B., Verburg, P.H., 2014. Spatial quantification and valuation of cultural ecosystem services in an agricultural landscape. *Ecological Indicators*. 37, pp. 163–174.

Villamagna, A.M., Mogollón, B., Angermeier, P.L., 2014. A multi-indicator framework for mapping cultural ecosystem services: The case of freshwater recreational fishing. *Ecological Indicators*. 45, pp. 255–265.

Wainger, L., Mazzotta, M., 2011. Realizing the potential of ecosystem services: A framework for relating ecological changes to economic benefits. *Environmental Management*. 48, pp. 710–733.

Case Study No. 3

Non-economic Assessment using PPGIS Method

CONTENTS

3.12 Introduction

The concept of ES has contributed an essential step to recognize the dependence of human societies on natural ecosystems by connecting anthropogenic benefits with biophysical aspects (Häyhä *et al*. 2015). With the publications of landmark studies such as Costanza *et al*. 1997, MA. 2005, or TEEB. 2010, ES has made its way into academia and policy circles, representing a sustainable growing number of scientific literature and associated policies (Christie *et al*. 2012; Rall *et al*. 2015). The concept has drawn considerable attention as it could facilitate a platform to integrate different worldviews, including scientists from multiple disciplines: ecologists, economists, socialists, *etc.,* to policy planners, and relevant nonprofessionals (Schröter *et al*. 2015). Throughout the evolution history of ES, several valuation methods have been developed to account for the biophysical, economic, and social aspects of the human benefits contributed by ecosystems, which accrue to the multidisciplinary characteristic of the concept (MA 2005, TEEB 2010, Christie *et al*. 2012).

Mostly driven by the prospects of utilitarian approaches to decision support (*e.g.*, Steiner *et al*. 2004; Baker *et al*. 2013) and more importantly, the relative simplicity of data collection and computation, ES evaluation studies are strongly focused on the biophysical and economic aspects, whilst socio-cultural information is commonly overlooked (Plieninger *et al*. 2013). This imbalance also emerges from the vagueness of the social terminologies, *e.g.*, human needs, wants or satisfaction, and thus, difficulties to establish relationships with relevant ecological processes (Daniel *et al*. 2012). In other words, it is more challenging to quantitatively represent the social aspects of ES, yet their economic valuations essentially lack robustness, and thus predominantly neglected (Plieninger *et al*. 2013).

However, scholars such as Schaich *et al*. (2010) have raised their opposing voices that the incorporation of social-cultural features is essentially indispensable for a comprehensive accounting of the ecosystems contributions to avoid biased management and unwanted tradeoffs. Likewise, Chan *et al*. (2012) considered studies on social perceptions could facilitate greater cultural sensitivity and recognition of differences between respondent groups, which are crucial for sustainable management of natural resources. Even more vigorously argued, Martín-López *et*

al., (2012) believed that studies exploring social features: perceptions, attitudes, and beliefs are more likely to shed useful lights to human-nature relationships themselves compared to purely biophysical assessments.

The presented case study aims to contribute yet another evidence to underscore the relevance of social insights to the evaluation of the ES profile within the context of a biosphere reserve area of Vietnam's Mekong Delta. In particular, there is a substantial amount of related publications, including peer-reviewed papers that had explored the ecological characteristics of the site given its recognition as one of the world's Ramsar Sites (Box 3.2). Insightful assessments regarding the social aspects, however, are essentially missing from the existing related literature. This research henceforth sought to contribute bridging these gaps with an exploratory evaluation of significant ES and EDS across the research site, as perceived by the residents. Adopting a deliberative mapping approach, the research methodology of this case study is guided by the following questions:

- What types of ES and EDS do residents recognize on different land covers (LCs)?
- What are the geographic patterns of these (dis) services?
- What bundles of social preferences can emerge from different perceptions?
- How do these bundles of ES diverge acrosss the communities?

3.13 The research area

The research was performed at UMTNP, which contributes significantly to biodiversity preservation of Kien Giang Biosphere Reserve (BR) and Vietnam' s Mekong Delta, in the broader sense. The Park sits on the southeast of U Minh Thuong district, Kien Giang province (Fig. 3.21), covering the total area of 8,038 ha between Minh Thuan (MT) and An Minh Bac (AMB) communes, and supporting one of the largest peat-swamp forests remaining in the country. UMTNP supports with an extensive collection of terrestrial and aquatic fauna species, including 32 mammals, 187 birds, 37 fish, and 203 insects. To accommodate such rich diversity, notable ES include the provision of fresh water, sustenance; the regulation of hydrology and climate regime; and the

protection from natural hazards. Regarding cultural values, UMTNP also offers nature observation and eco-tourism, educational activities, and cultural heritage. In fact, UMTNP is one of the most popular water birds viewing sites of the Mekong Delta, having received 44,000 visitors (97.5 % domestic and 2.5 % foreigners) and generated the revenue of USD 1 million in 2013 (Tran Ngoc Cuong, 2015).

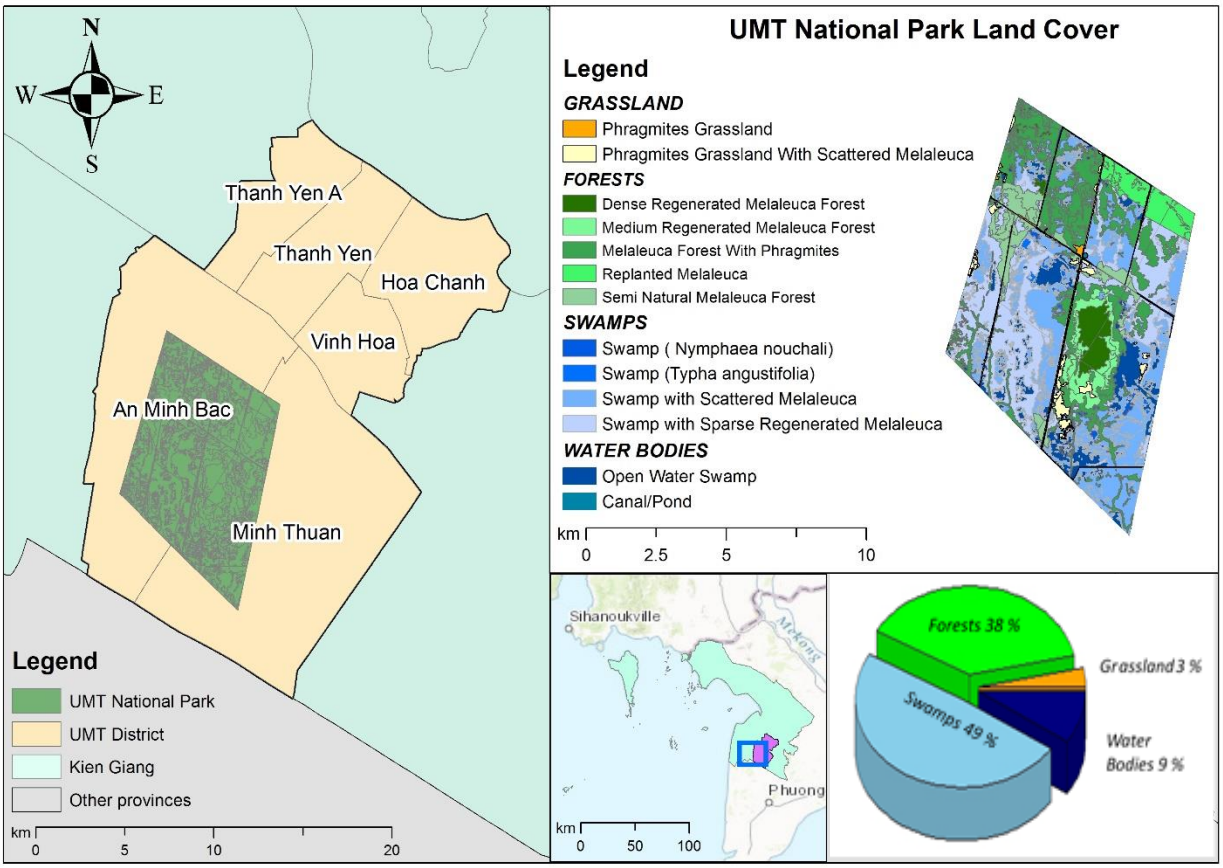


Fig. 3.21 The location of U Minh Thuong National Park, Vietnam

3.14 Methodology

3.14.1 Research Design

Monetary versus Non-monetary valuations

In the initial stage, secondary data about the biophysical and ecological characteristics of UMTNP was collected through the Ramsar website (http://www.ramsar.org/) and other related publications, including related peer-reviews manuscripts and official documents. One of the most important part while designing this study relates to the decision between monetary and non-

monetary valuations. Even though the ES community largely prefer the interpretation of human nature nexuses using money terms for its simpler handling using utilitarian evaluations (Wainger and Mazzotta 2011; Beery *et al*. 2016), this study opted for an opposite approach. The decision is because the economic valuations of protected sites entail various calculation pitfalls such as double counting and scale irrelevance (Hein *et al*. 2006). Plus, even if seemingly robust, valuation outcomes would be of limited pertinence given the designated functions of such areas, which are not for revenue generation.

Public Participatory GIS

This case study aims to perform a public participatory mapping GIS (PPGIS) that combines questionnaire based surveys with digital spatial techniques to collect, analyze and represent stakeholders' data in geographical forms (Fagerholm & Käyhkö 2009). Within the related literature, this method has proved to be useful in urban planning and natural resources management as it could localize the most highly valued ecosystems within a landscape (Bryan *et al*., 2010), and facilitate better comparisons among different types of services (Nelson *et al*. 2009). More importantly, through participatory exercises, place-based knowledge of stakeholders that are essentially missing from the literature of expert disciplined approach can be accounted for (Fagerholm *et al*. 2012; Plieninger *et al*. 2013). Within this study, the method to collect spatial data from participants includes pre-identifying sites on the map and representing them in questionnaires (Plieninger *et al*. 2013), generally similar to the case study No. 2.

3.14.2 Evaluated Services and Disservices

The survey was initiated with the list of services to evaluate adopted from the categories of MA (2005) and Ninan & Kontoleon (2016); with the abstract map of the research area as depicted in Fig. 3.20 to the participants. However, during the pre-test period, it was observed that participants faced major difficulties in: (1) differentiating among sub-categories of forests, swamps and (2) grasping highly theoretical definitions, *i.e.,* carbon sequestration or genetic resources preservation. As a response, the author decided to simplify the land cover classification and remove implicit definitions from the list of evaluated services. Additionally, four types of EDS representing concurring disturbances highlighted by Tran Triet, (2012) and Tran Ngoc

Cuong, (2015) were later added in the final version of the questionnaire. The classifications, definitions, and descriptions of LCs, ES, and EDS officially used in the surveys were summarized in Table 3.8. Besides, the interviewers also used suggestive materials being the photographs in Fig. 3.22 to help respondents in associating the questions with their experiences.

Table 3.8 Classifications of Land covers and (Dis) services

Land covers		**Descriptions**
Forests		Predominantly melaleuca forests with different densities
Grassland		Mostly Phragmites Grassland and scattered Melaleuca
Swamps		Swamps with Nymphaea Nouchali, Typha Angustifolia, and Melaleuca (scattered)
Water bodies		Open water swamps and canals
Services & Dis-services		**Definitions**
Provisioning	Water	The supply of fresh water for multiple purposes
	Fishing	The provision of edible fish, shrimp, crab, *etc.*
	Timber	The supply of wood
	Grazing	The provision of grass for grazing purpose
	NTFP	The supply of non-timber consumable goods from forests, *e.g.*, beehives, herbs, wood chips, *etc.*
Regulating and Supporting	Soil conservation	The ability to keep the soil from erosion
	Nutrients Cycling	Capacity to make the soil fertile
	Air purification	Capacity to supply fresh air and cool atmosphere
	Habitat	The appearance of a variety of wild animals, birds, fish, *etc.*
Cultural	Recreation	Respondents' relaxations
	Tourism	The appearance of outside visitors
Dis-services	Fire	Fire emerged from natural or anthropogenic reasons
	Disease	Fever, malaria, dengue, *etc.*
	Animal attacks	Disturbances and threats from wild animals, birds, *etc.*
	Others	Other disturbances or threats

3.14.3 Data collection

The existing literature

From February 22nd, 2015, UMTNP had been recognized as the 8th Ramsar site of Vietnam, and the 2,228th worldwide (Box 3.2). This recognition is crucial to raise public awareness about the ecosystems significance though the publication of the Ramsar Information Sheets (RIS). The RIS of UMTNP (prepared by the Biodiversity Conservation Agency, Environment Protection Administration, Ministry of Natural Resources and Environment, Vietnam) includes fundamental information about the National Park, ranging from basic natural attributes, *e.g.*, area,

hydrological regime, major LCs to ecological descriptions, *e.g.*, abundance, representativeness and rarity of species, and associated (dis) services. Other publications related to the research area including BirdLife International and MARD (2004), Nguyen Ngoc Bao Hoa (2005), Nguyen Van De (2002), and Institute of Tropical Biology (2002), Tran Triet (2002), and UMTNP (2013) were also thoroughly analyzed.

Box 3.2 The Ramsar Convention

Ramsar is one of the oldest of the modern global environmental agreements. The treaty was negotiated through the 1960s by countries and non-governmental organizations about the increasing degradation of wetlands habitats. The term Ramsar was taken after the name of Iranian city where the convention was adopted in 1971 and later came into force in 1975. The ultimate mission of this convention is to provide the frameworks for national actions and international collaborations for the conservation and wise use of wetlands and their resources. Within the convention, the term Ramsar site was used to refer to important wetlands in the world about the representativeness, rare species, abundance, and significance of water birds and aquatic fauna, *etc*. Up to date, there have been 2,242 Ramsar sites with the total area of 215,253,716 ha successfully identified in 169 contracting countries. Vietnam joined the convention in January 20th, 1989 and had contributed eight sites with UMTNP being the latest recognized.

(*Source: http://www.ramsar.org/about/history-of-the-ramsar-convention)*

Household surveys

The targeted populations for this study were the local settlements of approximately 4000 households inhabiting along 38 km boundary of UMTNP. Following the suggestions of Whittington *et al*., (1990) who underlined the major issue of participatory studies in developing countries as the predominant low response rates of self-administered methods, such as emails or phone calls, face-to-face interviews was chosen. At first, the first draft of the questionnaire was pre-tested in June 2016. Difficulties observed during this experimental period were collectively studied to improve the questions (words, structures, *etc.*) and learn how to conduct the interviews better. Adjustments to the latter issue were of particular importance as our targeting respondents

themselves are among standing threats to the biosphere reserve area though illegal encroachment, animals trapping, and causing forest fires, hence the hesitant behaviors to interviews (Tran Triet . 2002; Tran Ngoc Cuong, 2015). Thus, the local facilitator was contacted to help the interviewers in familiarizing with the residents and conduct the surveys, under the condition that no personal information would be disclosed afterward. The survey was finished in three weeks from August 6th - 30th 2016.

The interviews started with the introduction about the purposes of the study. Subsequently, the interviewers explained in general about the importance of ecosystems and the benefits they provide to humans. Then respondents' preferences with respect to significant ES and EDS were collected through participatory mapping. During these exercises, respondents were requested to conduct two following tasks: identify the presence of ES and EDS among four different LCs: Forests, Grassland, Swamp, and Water bodies and quantitatively evaluate them based on a ten-level Likert scale, in which one through ten represents ascending quality. To better facilitate respondents, the answer sheets had been prepared as matrixes, in which the columns represent different LCs while the rows depict the list of ES and EDS. Finally, respondents' demographic attributes, *e.g.*, Age groups, Genders, Education, Residency status (immigrants versus natives), and especially, their perceived dependence on the natural resources of the area were collected. Each interview took approximately 40 to 50 minutes.

a. Forest

b. Swamp

c. Water bodies

d. Grassland

Fig. 3.22 Typical land covers of U Minh Thuong National Park

3.14.4 Data Analyses

The thrust of this study is to understand where and how residents intuitively realize ecosystems associated benefits (ES) and disturbances (EDS) across UMTNP landscape. Also, how this information diverged according to respondents' backgrounds were also of particular interest. To accommodate these curiosities, the author performed a series of multivariate analyses using data collected from 94 individual questionnaires. Albeit relatively small considering 4000 households of the entire population, this sample size is comparable to the existing ES evaluation and mapping research using community-scale interviews, see for example, Plieninger *et al*., (2013); Raymond *et al*., (2009); or Loc *et al*., (2016).

Initially, Correspondence Analysis (CA) was applied to the count data regarding how many times each sub-category of (dis) services was nominated across four different LCs to detect any underlying structured bundles between these two variables. Subsequently, how the quality of ES / EDS as perceived by respondents diverge according to their social attributes were analyzed through Principal Component Analysis (PCA). The active variables of this analysis are the points allocated for each type of ES or EDS, accumulated from different LCs while the socio-demographic information of respondents were included as supplementary variables. To discover the bundles of social preferences, Hierarchy Cluster Analysis (HCA) was performed through the Euclidean distance and Ward's agglomerative method (Ward, 1963) utilizing the factor maps generated from PCA. The sample verification of data was conducted using Bartlett's Test for

Homogeneity of Variances (Bartlett, 1937) and Kaiser-Meyer-Okin Measure of Sampling Adequacy (Tabachnik and Fidell, 2001). To confirm the adequacy of the principal components generated, we followed the Kaiser Criterion (Hair *et al*., 1998). All of the analyses above were completed with the aid of FactomineR (Le *et al*., 2008; Husson *et al*., 2015; R Core Team 2015).

3.15 Results

3.15.1 Characteristics of Respondents

With respect to gender, male is predominant with 74 %given their leading roles in families' matters in the local communities. Only 6% of the respondents were over 60 years old while 47 % were between 40 and 60, and 42 % were under 40. Regarding occupations, 72 % have agriculture-related jobs while the rest include small business, fishing, or workers, all of which were typified as *Others* given their minor individual accounts. Respondents who were natives (living for more than 3 generations) account for sixty-five percent of the entire population. With respect to education attributes, only eleven respondents have finished high school while the majority dropped out in secondary or primary classes (43 % and 45 %, respectively). The self-perceived dependent levels on the natural resources were also analyzed, which gave almost balanced results with 49 out of 94 replied with non-dependencies. Among the latter, 15% expressed solely dependent livelihoods.

3.15.2 Services and Disservices

Services with the most entries (n = 205) was Habitat, followed by Soil Conservation, Water supply, Fishing, Air purification, Nutrients cycling, NTFP, Timber, Recreation, Tourism and Grazing. It is noteworthy that Regulating and Supporting services are the most identified services (n = 582), followed by Provisioning services (n = 507) and cultural services (148). Disservices, in general were recognized with a far lesser degree. More specifically, the most identified EDS was Disease (n=70), followed by Fire (n=67), and Animal attacks (n=48). The "*Others*" category of EDS had only four entries, hence disregarded for data analysis (Fig. 3.23).

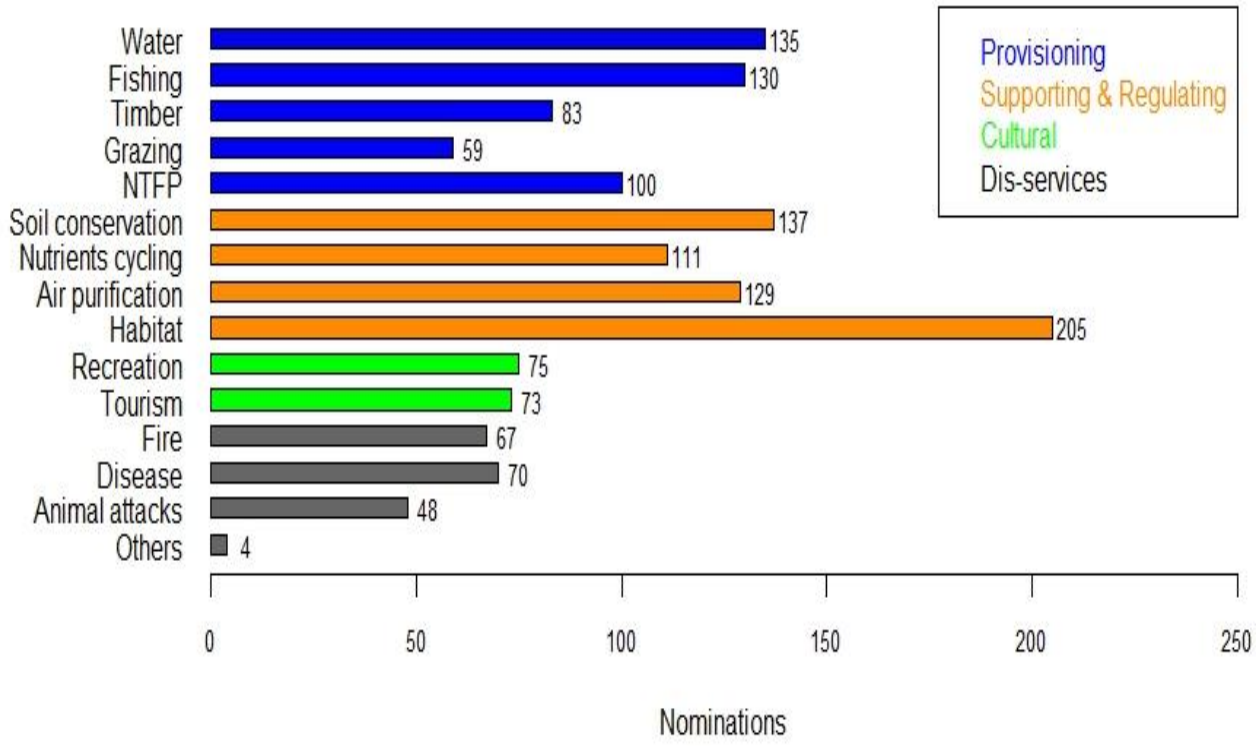


Fig. 3.23 Total entries of Services and Disservices

3.15.3 Relationships to Land Covers

Within UMTNP, Swamps and Forests are the predominant LC, covering 49 % and 38 % of the total area, respectively; whereas Water bodies and Grassland only account for 9 % and 3 % of the total area. In general, Forests is the LC with the highest intensities of recognized ES, accounting for 649 out of 1,237 entries, Water bodies, Grassland, and Swamps account for 279, 222, and 87 entries, respectively. Besides, with 150 out of 189 entries, EDS are exclusively associated with Forests, regardless of classifications. The associations of ES are substantially different among four types LCs. More specifically, Regulating and Supporting services *i.e.*, Soil conservation, Nutrients cycling, Air purification and Habitat are the most recognized benefits of Forests, Swamp and Grassland whereas the most significant services of Water bodies are Provisioning services: Water and Fishing. All of the aforementioned variations were visually explained in Fig. 3.24.

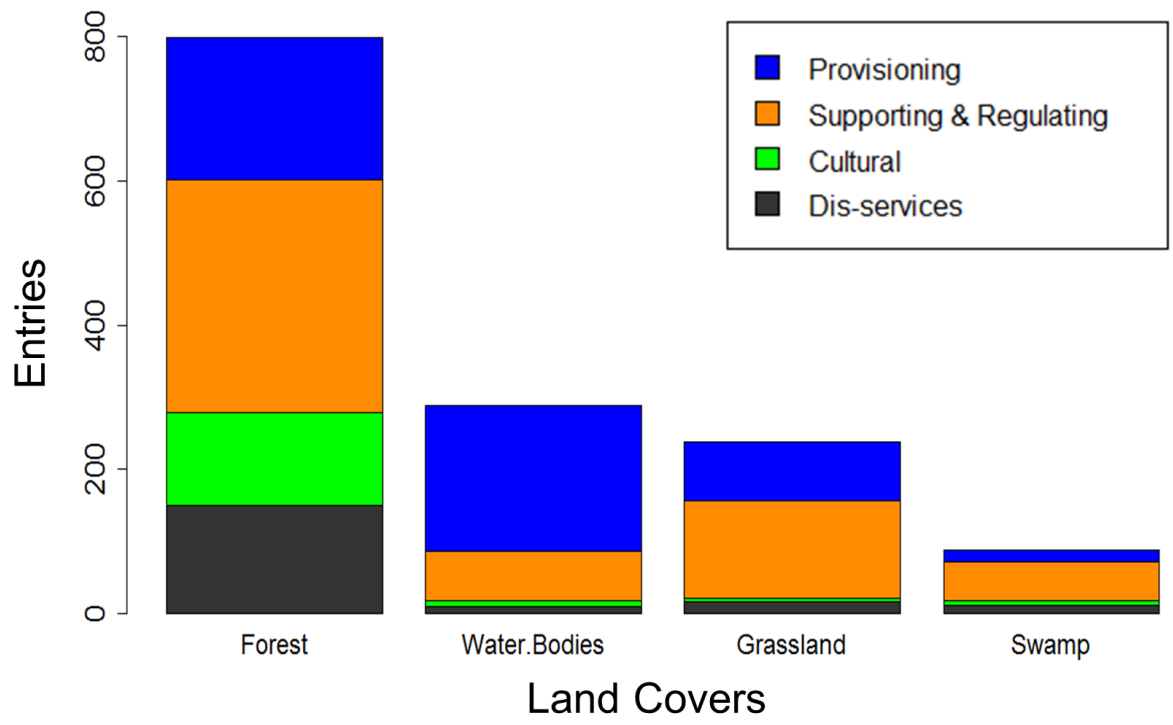


Fig. 3.24 (Dis) services nominations on different land covers

Differences regarding associated ES and EDS among LCs within the research area were in-line with findings from CA. The first two axes accounted for ninety percent of the inertia (Fig. 3.25). The first axis (57.85 % of inertia) differentiates between terrestrial related services: NFTP, nutrients cycling, soil conservation with aquatic related ones: Water supply and Fishing. The second axis (32.21 % of inertia) separates the Forest associated services: Timber, Tourism with all EDS: Animal attacks, Disease, Fire with those relevant to Swamps: Habitat and Grasslands: Grazing. In Fig. 3.23, the ellipses represent the statistically significant differences among LCs with respect to the abundance of (dis)services based on the confidence level of 95 % (Husson *et al.*, 2015). More specifically, Forests associated ES include Timber, Recreation, Tourism; Water Bodies' include fishing and water supply, Swamp' s include Habitat and Grasslands' include NTFP and Grazing. EDS are exclusively associated with Forests. Besides, some specific ES: Nutrients cycling, Air purification, and Soil conservation are relatively close to the origin, which means these actual observations are only slightly different from theoretical samples of the independence model. In other words, these services are not explicitly associated with either of the LCs.

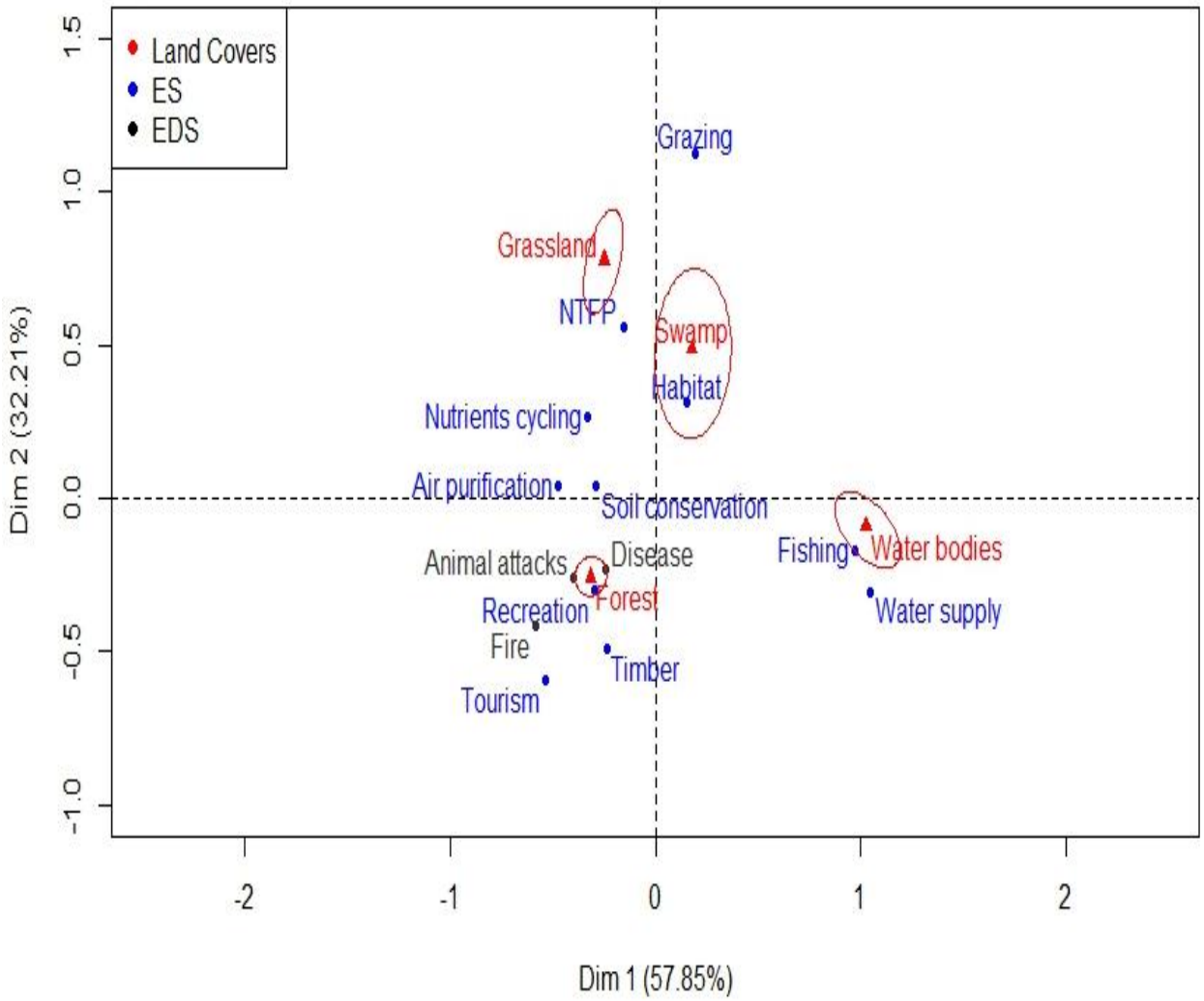


Fig. 3.25 Scatter plot of the first two axes of the correspondence analysis (CA)

These tendencies are in line with the aggregated spatial patterns of services entries on different LCs. Fig 3.26 illustrates the intensity of each ES/EDS in terms of nomination values. In general, the majority of (dis-)services are the most associated with Forests. The exceptions include Water Supply, Fishing, which are the highest in Water bodies. Similarly, Grazing is the most related to Grassland.

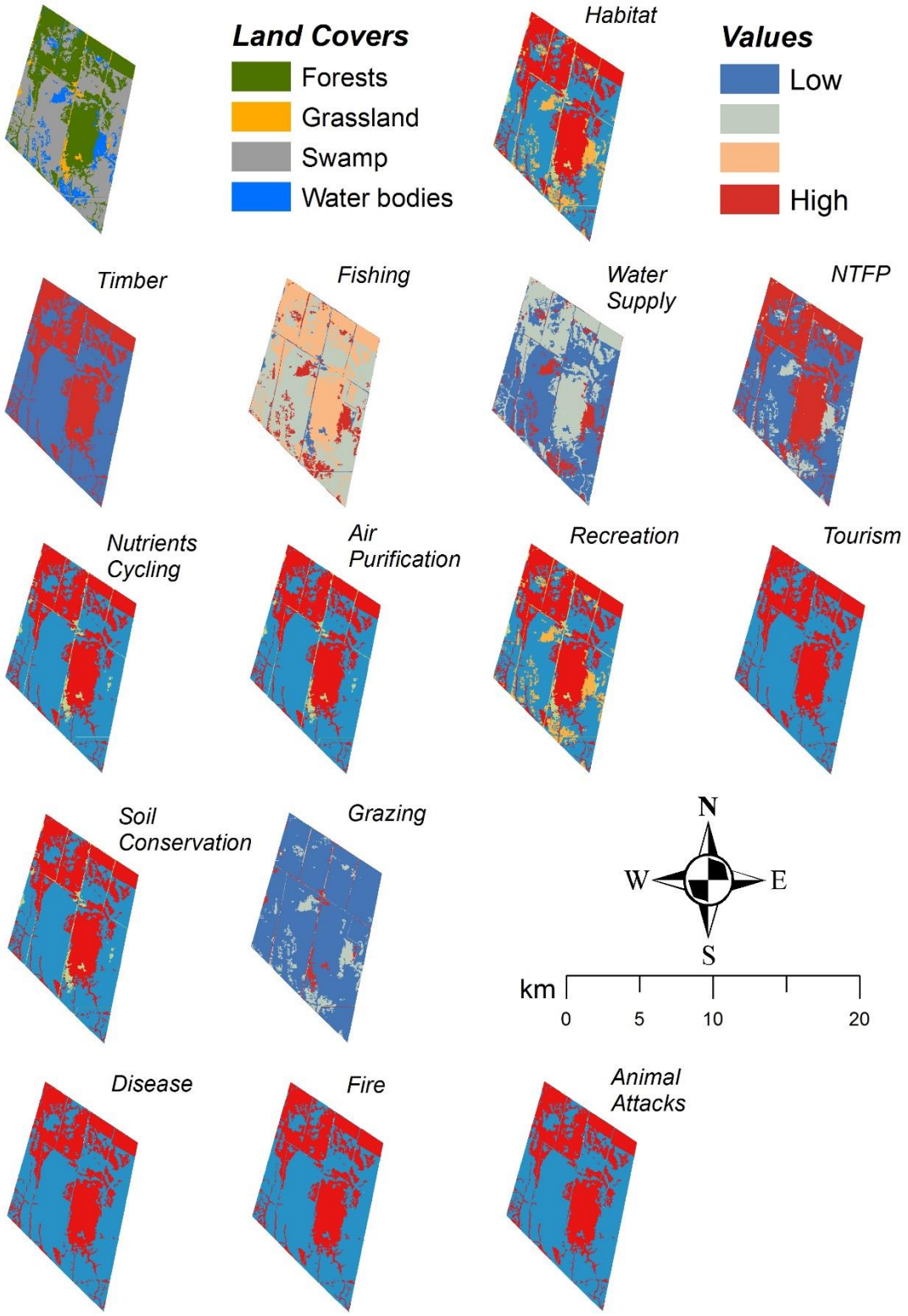


Fig. 3.26 Spatial distributions of each evaluated (dis-)services

With regard to diversity, while Forests, Swamps and Water bodies all feature 11 different types of services, their Shannon indexes(*) lightly differed: 2.290, 1.804, and 1.85, respectively. Grassland index equals 1.986 despite featuring only 10 different ES. Largely agrees with Fig. 3.24, disservices is predominantly associated with Forests (n = 150) whilst Grassland, Swamps and Water bodies respectively feature 16, 11 and 9 nominations (Fig. 3.27).

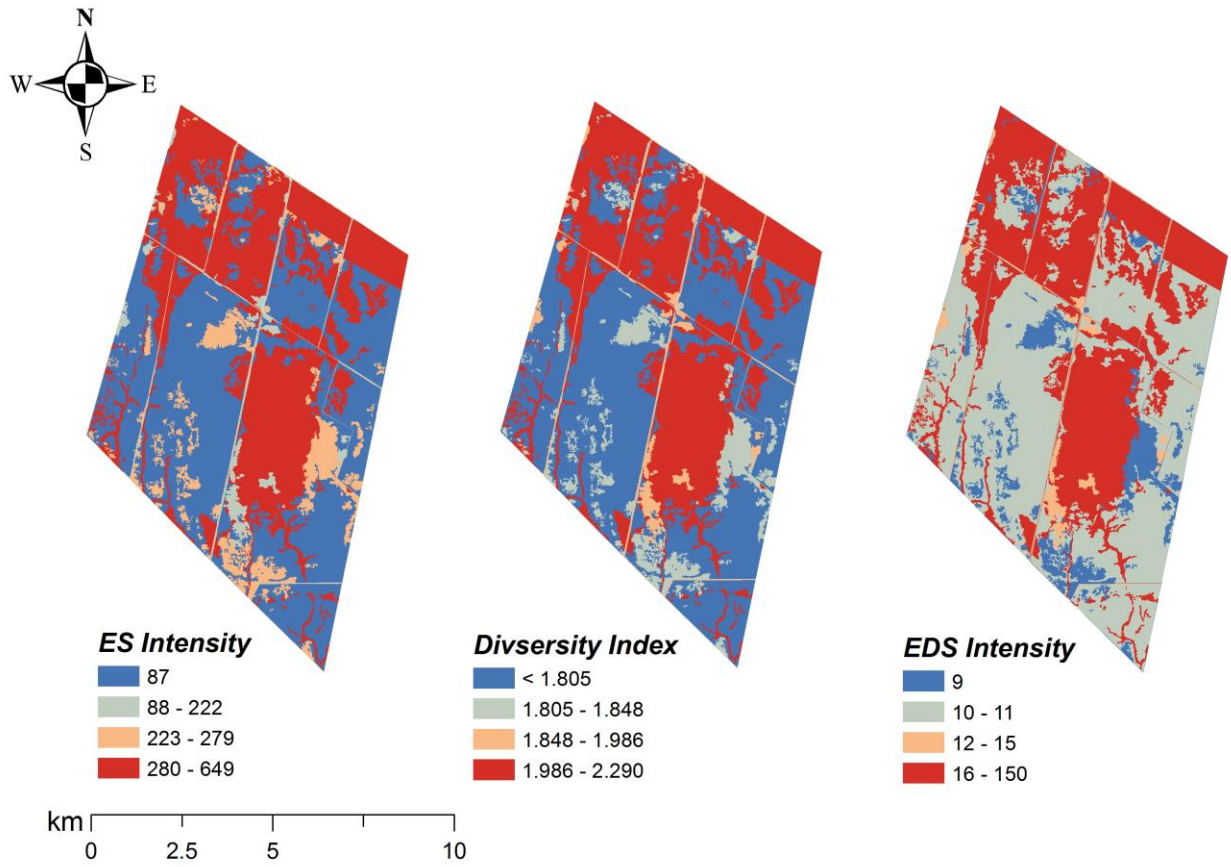


Fig. 3.27 Aggregated patterns of (dis) services

3.15.4 Relationships to Social attributes of Respondents

General Perceptions towards ES and EDS

Fig. 3.28 depicts the averaged points allocated to each types of ES and EDS, accumulated from four different LCs. It should be first noteworthy that, respondents' evaluations substantially diverse across the list of ES (EDS) and are mostly associated with the biosphere reserve function of the research area. More specifically, being a National Park, the extractions of consumable goods,

such as Timber, beehives, *etc.* are generally limited, hence the comparatively lower points of Provisioning services. Within this category, only Water (11.14) and Fishing (9.07) are comparable to Supporting and Regulating services provided that the utilization of these two resources are relatively less restricted. Similar to the general trend of Fig. 3.22, Habitat is the most highly graded benefits of the area (16.07), followed by the associated Supporting services: Air purification (11.91), Soil Conservation (11.09), and Nutrients cycling (9.01). The fauna population, which contributes to the Habitat, is at the same time relevant to considerable concerns of Animal attacks (10.18) compared to other types of disservices. Finally, the associated eco-tours services are currently provided by the management board of UMTNP with limited participation of the community, hence the relatively underrated Recreation and Tourism services.

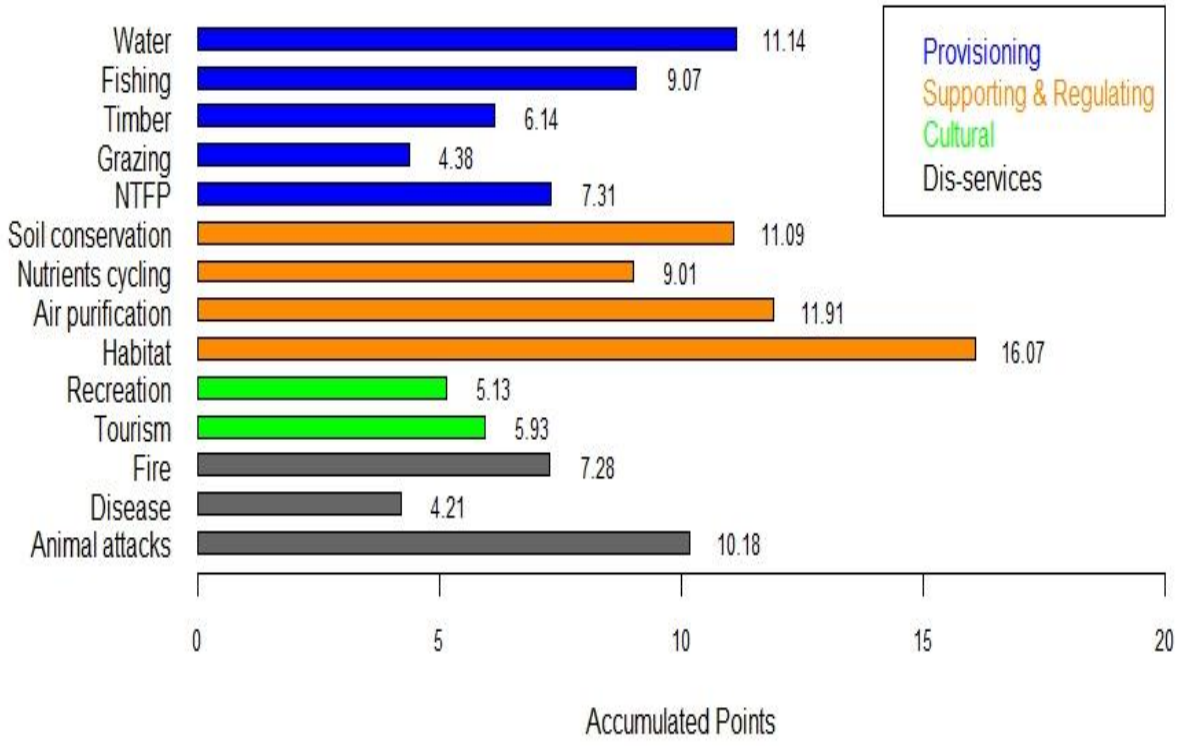


Fig. 3.28 Stakeholders' perceptions towards ES and EDS

Multivariate Analyses

Findings from PCA are visually summarized in Fig. 3.29, in which the first three principal components (axes) together accounted for 55.88 % of the total inertia. More specifically, the first axis (25.38 % of inertia) was significantly and positively related to NTFP, Tourism, Nutrients

Cycling, and Fishing; the second axis (19.20 % of inertia) was positively related to Water Supply, Habitat and negatively related to Recreation; the third axis (11.30 % of inertia) was positively related to Air purification and negatively related to Timber. With respect to the associations between ES, two revealed bundles are (1): Water supply, Soil conservation, and Habitat; and (2): Nutrients cycling, Tourism, and NTFP, signifying positive relations among these services. In consideration of effective representation, on variables contributing the most to the explaining power of each principal components, which contribute 60 % of the total inertia are plotted.

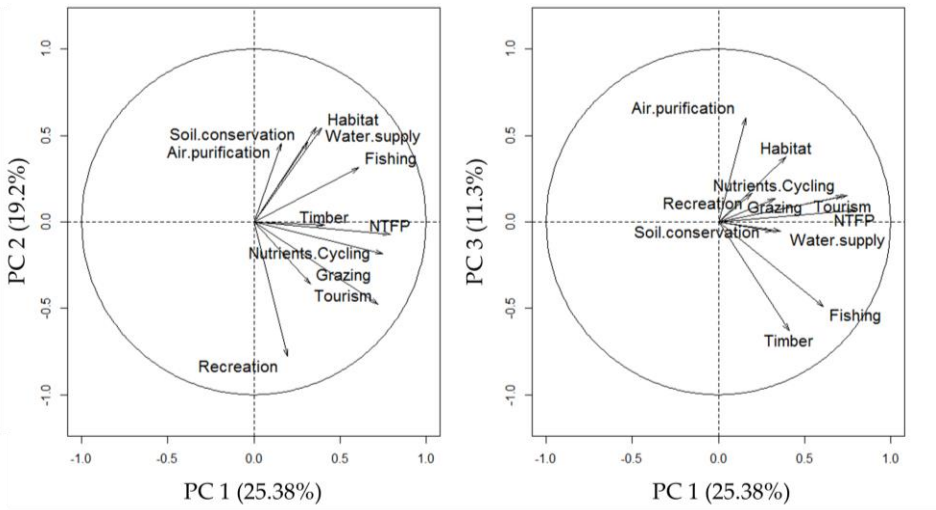
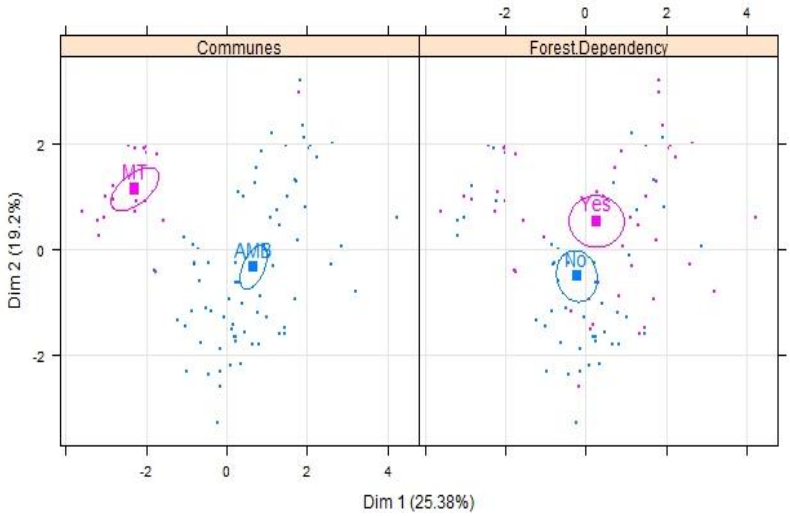


Fig. 3.29 Plots of associated variables of the first three axes of PCA

The diversity of respondents' perceptions about relevant (dis) services by their social backgrounds were explored through two subsequent analyses: hypothesis tests for categorical demographic variables (age groups, gender, communes, *etc.*), and HCA. Findings from the first approach revealed significantly different responses between (1) participants who were dependent on natural resources *versus* who were not, and (2) participants from MT *versus* AMB communes. More specifically, those respondents whose livelihoods are resources dependent are likely to give higher points to Soil Conservation, Habitat and Air purification and lower points to Grazing than the other. Likewise, AMB communities expressed comparatively higher regards to Tourism, Nutrients Cycling, NTFP, Recreation, Grazing, Timber, and Fishing services than MT, which might emerge from the different relative locations between each community and the forests. These disparities, however, should only be taken for granted given the imbalanced

sampled populations between MT (n = 22) and AMB (n = 72). Fig. 3.30 illustrates how respondents categorized by different social variable diversify, in which non-overlapping ellipses depict statistically significant differences.



Notes:

MT: Minh Thuan

AMB: An Minh Bac

Yes: Depend on

No: Independent

Fig. 3.30 Confidence ellipses of PCA

Utilizing HCA, the underlying bundles of social preferences towards relevant ES within the community could be revealed. Particularly, individuals with similar attributes were grouped into Clusters through their relative Euclidean distance based on Ward's criterion (Husson *et al.*, 2010), as depicted in Fig. 3.*31.*

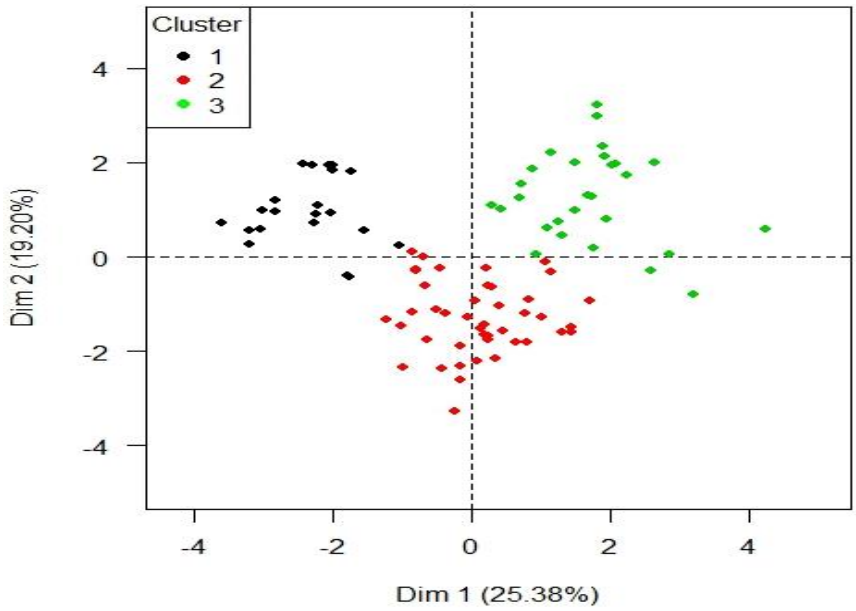


Fig. 3.31 Individuals factor map from HCA

In principal, each Clusters' characteristics are described by comparing their attributes with the respective figures of the Population, with the consolidation of results conducted with a confidence level of 95 %. For instance, Tourism is significantly underrated by Cluster 1 given its averaged points is only 0.64 compared to 5.92 of the entire Population ($p = 1.15 \times 10^{-13}$). Table 3.9 summarizes the statistically significant differences between the Clusters and the whole population ($p \leq 0.05$); in which NAs denote insignificant variations.

Table 3.9 Characteristics of each cluster

(Dis) services	Population	Cluster 1	Cluster 2	Cluster 3
Water	11.14	NA	8.75	15.36
Fishing	9.07	5.82	7.66	13.86
Timber	6.14	3.77	NA	7.64
Grazing	4.38	1.50	6.11	NA
NTFP	7.31	1.0	NA	10.93
Soil conservation	11.09	NA	9.48	13.71
Nutrients cycling	9.01	0.4	NA	13.61
Air purification	11.91	NA	10.45	14.07
Habitat	16.07	NA	11.41	24.04
Recreation	5.13	2.45	8.14	2.5
Tourism	5.93	0.64	7.57	7.5
Fire	7.28	NA	NA	NA
Disease	4.21	NA	NA	2.54
Animal attacks	10.18	NA	NA	11.64

Notes: Green and Red shades depict higher and lower points compared to the Population, respectively.

Cluster 1 represents the group with the most pessimistic attitudes towards the natural resources of UMTNP, having lowly rated Fishing, Timber, Gazing, NTFP, Nutrients Cycling, Recreation and Tourism services. Conversely, the assessments from Cluster 3 are better than the average of the population, except for Recreation. This group of respondents is also significantly less concerned about Disease. Standing in between are those respondents forming Cluster 2, who have high regards for Water supply, Fishing, Soil Conservation, Air purification, and Habitat while lowly evaluate Grazing, Recreation, and Tourism. Plus, through the supplementary variables, Clusters are also distinguished by social attributes of contributing individuals. More specifically, the clouds of Cluster 1 are built up mostly by the young to middle-aged respondents from MT commune; while Cluster 2 consists of AMB residents, who were not dependent on the natural resources, and mostly did not drop out until high schools. Finally, those natural resources

dependent residents from AMB commune constitute the cloud of Cluster 3. In conclusion, HCA results largely agree and consolidate the preliminary findings from hypothesis tests regarding the differences between respondents groups.

3.16 Discussions

3.16.1 Methodological Implications

The presented method in this research was adopted from the renowned deliberative mapping technique for assessing landscape values through the aid of the local communities (Fagerholm and Käyhkö 2009; Kingston *et al*., 2004; Voss *et al*., 2004 and Plieninger *et al*., 2013). This case study aims to propose a slightly different approach, using contingency tables to collect the spatial distribution and values local people attach to different (dis) services across the research area. One important benefit of this technique lies in the simplified mapping tasks for participants compared to the uses of sticker dots, point markers to delineate zones (see for instance, McIntyre *et al*., 2004; Brown 2005). Besides, another noteworthy advantage relates to the alleviated workload in data processing, as the primarily collected data was already in preferable forms for the subsequent statistical analyses methods *i.e.,* CA, PCA and HCA. There are however some challenges emerged from this approach that will be further discussed in the following section.

Within the presented case study, the use of photographs also contributes an important methodological implication. The necessity of these materials was recognized through the respondent' difficulties to grasp the LC classification during the pre-tests. As a response, besides revising the questionnaire, additional suggestive materials were utilized to support the interviewers' verbal explanations. In fact, UMTNP related images were readily available on the Internet given the popularity of the site, however, were not useful due to their low resolutions; and more importantly, the constantly changing looks of the landscapes within the course of a year. For instance, certain Swamps areas could be easily confused with Grassland during the dry months due to extensive evaporation.

3.16.2 Community Involvement

This case study sought to capture the real knowledge of the local community living along the boundary of UMTNP. From our findings, these local inhabitants have demonstrated solid understanding regarding the natural resources of the area, which cumulatively evolve from their daily experiences. This place-based knowledge, however, is currently missing from the associated literature of the area. This research hence strived to contribute an exploratory assessment of these aspects using participatory data collection combined with three multivariate analyses techniques. More specifically, the comparatively greater amount of entries attached to non-consumable values *i.e.*, supporting, regulating services, and their comparatively highly regarded statuses in substantially ratified respondents' awareness about the importance of these natural processes. Alternatively, the less significant entries of Tourism and Recreation services indicate the limited participation of the local community in the eco-tours currently operated by the management board of UMTNP. The bundled of ES in CA also subtlety resonate with respondents' capacity to identify relevant benefits and disturbances across the landscapes, for instance through the exclusive associations of aquatic-related services with Water bodies, or the particular attachment of Fires, Disease and Fire to Forests. These observations accumulatively highlighted the relevance of local expertise to consolidating the baseline understanding of ES characteristics of the research area (Kingston *et al*., 2004; Voss *et al*., 2004 and Plieninger *et al*., 2013).

Another finding from the interviews relates to the language *i.e.,* the different perceptions for the same (dis) services between ES trained personnel and the local nonprofessionals. By "language differences," we referred to the way local stakeholders intuitively perceive ecosystems contributions emerging from daily activities without having to refer to any ES textbooks. Realizing ways to overcome these barriers are therefore necessary to narrow down the gaps between relevant actors and realize opportunities to capture relevant social insights (Greenhalgh and Hart 2015; Verburg *et al*., 2016). As a contribution to these regards, this case study presents a participatory method, which is essentially more participants centered. Mostly differed from other pedagogical approaches; the PPGIS exercises substantially centralized participants' roles within the data collection processes by encouraging them to express their knowledge in a deliberate

manner through sketching exercises. This method could have facilitated more informal interviews by not trying to communicate about highly theoretical terminologies thus essentially reduce the risks of information loss or distortions emerged from confusions or misunderstandings. More importantly, solid outputs from this method have substantially addressed the concerns raised by scholars such as Waters *et al*., (2012) or Verburg *et al*., (2016) about the "uncertain end points" of community involvement processes.

3.16.3 The Social dimension of ES Analytical Framework

Through its evolution, the concept of ES had been established on two distinctive pillars of knowledge: ecology and economy (Braat and de Groot 2012), hence the predominant focus on the assessments of these two aspects in current studies (Plieninger *et al*., 2013). To support decision-making, the gameplay of ES should expand towards the domain of social aspects. The sensitivity accounts of relevant stakeholders' characteristics, needs, and responsibilities are important to understanding the contributions of natural resources to human wellbeing on the one hand; and avoiding biased management of ecosystems on the other. In other words, the integration of social information in the ES analytical framework is relevant to bridge the gaps between academia and policy circles and to transfer the ES information closer to decision-making processes (Sitas *et al*. 2013; Nahlik *et al*. 2012)

One of the biggest challenges to this integration task is that social values could be comparatively harder to capture and represent than biophysical or economic counterparts, hence frequently ignored by disciplinary expert approaches (Gee and Burkhard 2010). Given its relevance to decision support, there is an ever-growing body of literature addressing the questions on how to effectively account for these typical values using monetary or non-monetary techniques (see for instance Christie *et al*., 2012, Atkinson *et al*., 2012, *etc*.). As a contribution to these efforts, this case study presented an operational method to capture the social values that residents from a developing community attach to their living landscapes. With the aid GIS, research outcomes were effectively incorporated into digital maps, which can simplify communications to landscape managers about the social profile of relevant ES. Moreover, the representation of social features using GIS resonates deeply with findings from biophysical and

economic evaluation studies hence could ease the incorporation of relevant findings and constitute to the truly comprehensive and interdisciplinary assessments of ES.

3.16.4 Contributions to Landscape Management

As previously mentioned, the motivation behind this case study is to provide social-based assessments for relevant ES and EDS within UMTNP, which are essentially missing from the existing body of literature. Deliberative mapping technique has enabled a sound understanding about the spatial distributions of ES and EDS across the research area landscapes as perceived by participants. Also, the revealed perception discrepancies between different resident groups are of particular importance to raising public awareness, recognizing potential conflicts associated with diverse communities, and identifying risks of harmful actions. These are typical examples where the presented findings can be of relevance to the sustainable landscape management strategies.

Firstly, the mismatch between the underrated Tourism and Recreation values from respondents and the substantial annual revenue from eco-tours essentially implies the need for public awareness improvement. Apart from common approaches such as propaganda or education, it might be as important to involve local inhabitants into the operation of the eco-tours, which could promote the protective behaviors within the local community. Secondly, bundles of ES evaluations identified in HCA could have implied the critical imbalances among the local inhabitant's perceptions. While some demonstrate high regards for the ecosystems benefits, others are not as such likely, which potentially lead to conflicts about the utilization and reservation of shared resources. The depreciating attitudes of specific individuals, on the other hand, resonate deeply with illegal animal trapping, water polluting, fires, *etc.* that have been alerted as standing threats to the National Park (Tran Triet. 2002 and Tran Ngoc Cuong, 2015).

3.16.5 Caveats

The most problematic matter encountered in this case study relates to the spatial scales, which has been extensively discussed by (Hein *et al*., 2006). Given that ecological attributes such as ES and EDS are associated with specific types of landscape (Brown, 2005; Plieninger *et al*., 2013), LCs were adopted as the mapping units. As mentioned above, the abstract map representing LC

classifications in Fig. 3.20 was primarily simplified responding to the pretest observations. Hence certain areas with diversified ecological characteristics were assumed homogenous. For instance, swamps areas with different vegetation coverages: Nymphaea Nouchali, Typha Angustifolia, or scattered Melaleuca were similarly categorized whereas their associated flora and fauna systems could be highly diversified and site-specific. It should also be noted that ecological attributes assessments were not among our primary targets given that these aspects have been much discussed in the existing literature (*e.g.,* Nguyen Ngoc Bao Hoa 2005; Nguyen Van De 2002; or BirdLife International and MARD 2004). Therefore, findings from public participatory approach should not be directly associated with the variations of relevant ecological attributes, *e.g.,* resources stocks, biodiversity richness or associated risks across the landscapes (Fagerholm *et al*. 2012). For instance, the association of Habitat to Swamp within Fig. 3.24 might be solely due to the participants' frequent encounters with wild animals during their daily activities at specific sites, thus does not necessarily imply the richness of biodiversity of all the Swamp areas within the research site. These findings, could reveal relevant social preferences, based on which more robust evaluations could be achieved through finer mapping exercises (Norton *et al*., 2012), having respondents to delineate ES zones (Fagerholm and Käyhkö 2009), or adopting more comprehensive participatory methods such as In-depth Interviews, Rapid Rural Appraisal, Q-methodology, *etc.* (Christie *et al*., 2012).

The second challenge is associated with the participating population that was only formed by the residents while the research area also serves a significant amount of outside visitors for its popularity within the region. Specifically, the famous bird-viewing sites within the UMTNP have been attracting thousands of wildlife photographers as well as ornithologists, both domestic and international each year (BirdLife International and MARD. 2004). The perceptions of these visitors regarding the ecological significance of UMTNP, however, was not touched in the scope of this manuscript. It could be of particular interest to explore the differences between these visitors and local people about the assessments of relevant ES and EDS, for instance, inhabitants given the threat of potential attacks could negatively perceive wild animals that are the main attractions to tourists. Alternatively, the utility functions of outside visitors' are likely to be associated with Natural capital of the area, making their perceptions largely different from the local inhabitants

who attached cultural values or material values to their living environments (Plieninger *et al*., 2013).

3.17 Conclusions

The case study indicates that the integration of deliberative mapping approach with multivariate analyses is effective in assessing the local people's perceptions towards the landscape services. Various findings from this research could be useful for landscape management strategies, *e.g.,* the bundled of ES perceived on different landscapes, the geographic patterns of the perceived values across the research area, or the relationships between ES appreciation and participants' social backgrounds, *etc*. Actively involving the local community to raise awareness and encourage protective behaviors, recognizing potential risks emerged from imbalanced perceptions or identifying groups who are likely to commit harmful actions are among practical findings that can be of relevance to landscape managers. These largely agree with various scholars previously underlined the need of strengthened social dimensions within the evaluation frameworks in delivering outcomes that are more policy relevant.

As a contribution to methodological improvements, the presented approach has proved to be applicable in developing community contexts in producing solid outputs. The major benefits of this method lie in the simplified data collection method and the reduced workload in data processing compared to other approaches. Besides, the acknowledged difficulties associated with the spatial scales and the sampling of the population of this research are relevant to the findings scopes and the implications of future research needs.

Finally, yet importantly, results from public participatory studies are not necessarily better than top-down expert disciplined-based approaches (Stephenson 2008). These two forms of knowledge are integral components, complementing each other to form the holistic understanding of the "landscape values as a whole." Essentially, practical management strategies of landscapes cannot compromise either of the biological chemical, economic, or socio-cultural considerations, as the imbalanced representations among these factors could not guarantee any integrated and sustainable management strategies.

Notes

(*) Shannon diversity index is a popular quantitative measure used to reflect how many different types (in this case ES) there are in a data set, simultaneously taking into account how evenly the basic entities (in this case nominations) are distributed among those types of services. The Shannon index is calculated using the following equation:

$$\mathrm{H}' = \sum_{i=1}^{R} p_i \times lnp_i \quad \text{(Eq.2)}$$

Whereas p_i is the proportion of nominations belonging to the *i*th type of services. In the literature, Shannon index is the most widely used indicator to account for diversity; others include Rényi entropy, and Simpson index (Shannon 1948; Simpson 1947, Rényi 1961).

References

Alessa, L.N., Kliskey, A.A. and Brown, G., 2008. Socio-ecological hotspots mapping: a spa- tial approach for identifying coupled social–ecological space. *Landscape Urban Planning*. 85, pp. 27–39

Atkinson, G., Bateman, I. and Mourato, S., 2012. Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy*, 28(1), pp. 22–47.

Baker, J. et al., 2013. Ecosystem services in environmental assessment - Help or Hindrance? *Environmental Impact Assessment Review*, 40(1), pp. 3–13

Bartlett, M. S., 1937. Properties of sufficiency and statistical tests. *Proceedings of the Royal Statistical Society, Series A* 160, pp. 268–282.

Beery, T., Stålhammar, S., Jönsson, K.I., Wamsler, C., Bramryd, T., Brink, E., Ekelund, N., Johansson, M., Palo, T. and Schubert, P., 2016. Perceptions of the ecosystem services concept: Opportunities and challenges in the Swedish municipal context. *Ecosystem Services*, 17, pp. 123–130

Bird Life International and MARD. 2004 Sourcebook: Existing and proposed protected areas in Vietnam. Second Edition. Hanoi, Vietnam: BirdLife International Vietnam Program.

Braat, L.C. and de Groot, R., 2012. The ecosystem services agenda:bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosystem Services*, 1(1), pp.4–15

Brown, G. 2005. Mapping spatial attributes in survey research for natural resource management: methods and applications. *Society and Natural Resources*. 18(1). pp. 17 – 39.

Bryan, B.A., Raymond, C.M., Crossman, N.D. and Macdonald, D.H., 2010. Targeting the management of ecosystem services based on social values: where, what, and how? *Landscape and Urban Planning* 97, pp. 111–122.

Burkhard, B. and Müller, F., 2008. Indicating human–environmental system properties: case study northern Fenno-Scandian reindeer herding. *Ecological Indicators*. 8, pp. 828–840

Chan, K.M.A., Satterfield, T. and Goldstein, J., 2012. Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics* 74, pp. 8–18.

Christie, M., Fazey, I., Cooper, R., Hyde, R. and Kenter, J.O., 2012. An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. *Ecological Economics*, 83, pp. 67–78

Costanza, R., Arge, R., Groot, R. De, Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V, Paruelo, J., Raskin, R.G., Suttonkk, P. and van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature*, 387(May), pp. 253–260.

Daniel, T.C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J.W., Chan, K.M. a., Costanza, R., Elmqvist, T., Flint, C.G., Gobster, P.H., Gret-Regamey, A., Lave, R., Muhar, S., Penker, M., Ribe, R.G., Schauppenlehner, T., Sikor, T., Soloviy, I., Spierenburg, M., Taczanowska, K., Tam, J. and von der Dunk, A., 2012. Contributions of cultural services to the ecosystem services agenda. *Proceedings of National Academy of Science*. 109, pp. 8812–8819.

Fagerholm, N. and Käyhkö, N., 2009. Participatory mapping and geographical patterns of the social landscape values of rural communities in Zanzibar, Tanzania. *Fennia*, 187(1), pp. 43–60.

Fagerholm, N., Käyhkö, N., Ndumbaro, F., Khamis, M., 2012. Community stakeholders' knowledge in landscape assessments - Mapping indicators for landscape services. *Ecological Indicators*, 18, pp. 421–433

Gee, K. and Burkhard, B. 2010. Cultural ecosystem services in the context of offshore wind farming: a case study from the west coast of Schleswig-Holstein. *Ecological Complexity*. 7, pp. 349-358

Greenhalgh, S. and Hart, G., 2015. Mainstreaming ecosystem services into policy and decision-making: lessons from New Zealand's journey. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 3732(June), pp. 1–11

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. 1998. Multivariate Data Analysis, 5th edition. Upper Saddle River, NJ: Prentice-Hall.

Häyhä, T., Franzese, P.P., Paletto, A., Fath, B.D., 2015. Assessing, valuing, and mapping ecosystem services in Alpine forests. *Ecosystem Services*, 14, pp. 12–23.

Hein, L., van Koppen, K., de Groot, R.S. and van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological Economics*, 57(2), pp. 209–228.

Husson, F, Josse, J. and Pag`es, J., 2010. Principal component methods - hierarchical clustering - partitioning clustering: why would we need to choose for visualizing data. Applied Mathematics Department. Technical Report - Agrocampus.

Husson, F, Josse, J., Le, S. and Maze, J., 2015. FactoMineR: Multivariate Exploratory Data Analysis and Data Mining. R package version 1.31.4. From: http://CRAN.R-project.org/package=FactoMineR

Institute of Tropical Biology (ITB). 2002. Findings on the status of aquatic environment in U Minh Thuong National Park after the fire in March-April 2002. Report in the workshop on Restoration of U Minh Thuong National Park. HCM City: June 2002. (in Vietnamese)

Kingston, R., Carver, S., Evans, A. and Turton, I., 2000. Web-based public participation geographical information systems: an aid to local environmental decision making. *Computers, Environment and Urban Systems*. 24(2). pp. 109-125

Le, S., Josse, J. and Husson, F., 2008. FactoMineR: An R Package for Multivariate Analysis. *Journal of Statistical Software*. 25(1), pp. 1-18.

Loc, H H., Diep, N.T.H., Can, N.T., Irvine, K.N. and Shimizu, Y. 2016 (In Press). "Integrated Evaluation of Ecosystem Services in Prawn-Rice Rotational Crops, Vietnam." *Ecosystem Services*.

Mann, C., Loft, L. and Hansjürgens, B., 2015. Governance of Ecosystem Services: Lessons learned for sustainable institutions. *Ecosystem Services*, 16, pp. 275–281

Martín-López, B., Iniesta-Arandia, I., García-Llorente, M., Palomo, I., Casado-Arzuaga, I., Del Amo, D.G., Gómez-Baggethun, E., Oteros-Rozas, E., Palacios-Agundez, I., Willaarts, B., González, J.A., Santos-Martín, F., Onaindia, M., López-Santiago, C. and Montes, C.,. 2012. Uncovering ecosystem service bundles through social preferences. *Plos ONE*, 7, pp. 1-11

McCauley, D.J., 2006. Selling out on nature. *Nature*, 443(7107), pp. 27–28.

McIntyre, N., Yuan, M., Payne, R.J. and Moore, J., 2004. Developing value-based approach to managing recreation on Canadian Crown Lands. *Working papers of the Finnish Forestry Institute*. 2. pp. 285 – 283

Nahlik, A.M., Kentula, M.E., Fennessy, M.S. and Landers, D.H., 2012. Where is the consensus? A proposed foundation for moving ecosystem service concepts into practice. *Ecological Economics*, 77, pp. 27–35.

Nelson, E., Mendoza, G., Regetz, J., Polasky, S., Tallis, H., Cameron, D., Chan, K.M.A., Daily, G.C., Goldstein, J., Kareiva, P.M., Lonsdorf, E., Naidoo, R., Ricketts, T.H. and Shaw, M., 2009. Modeling multiple ecosystem services,

biodiversity conservation, commodity production, and tradeoffs at landscape scales. *Frontiers in Ecology and the Environment* 7, pp. 4–11.

Nguyen Phuc Bao Hoa. 2005. Report on the bird-monitoring program. Unpublished report to the U Minh Thuong Nature Reserve Conservation and Community Development Project.

Nguyen Van De. 2002. An initial survey and assessment on the status of soil environment in U Minh Thuong National Park. Unpublished report to the Sub-institute of Geography, VAST. (in Vietnamese)

Ninan, K.N. and Kontoleon, A., 2016. Valuing forest ecosystem services and disservices - Case study of a protected area in India. *Ecosystem Services*, 20, pp. 1–14.

Norton, L.R., Inwood, H., Crowe, A. and Baker, A., 2012. Trialing a method to quantify the 'cultural services' of the English landscape using countryside survey data. *Land Use Policy* 29, pp. 449–455.

Plieninger, T., Dijks, S., Oteros-Rozas, E. and Bieling, C., 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy*, 33, pp. 118–129.

R Core Team .2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. From: https://www.R-project.org/.

Rall, E.L., Kabisch, N. and Hansen, R., 2015. A comparative exploration of uptake and potential application of ecosystem services in urban planning. *Ecosystem Services*, 16, pp. 230–242.

Rényi, A. 1961. On measure of information and entropy. *Proceedings of the fourth Berkeley Symposium on Mathematics, Statistics, and Probability*, pp. 547 – 561.

Reyers, B., Polasky, S., Tallis, H., Mooney, H.A. and Larigauderie, A., 2012. Finding Common Ground for Biodiversity and Ecosystem Services. *Bioscience*, 62(5), pp. 503–507.

Schaich, H., Bieling, C., Plieninger, T., 2010. Linking ecosystem services with cultural landscape research. *GAIA*, 19, pp. 269–277

Schleyer, C., Görg, C., Hauck, J. and Winkler, K.J., 2015. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. *Ecosystem Services*, 16, pp. 174–181

Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S. and Opdam, P., 2014. Ecosystem Services as a Contested Concept: A Synthesis of Critique and Counter-Arguments. *Conservation Letters*, 7(6), pp. 514–523.

Schröter, B. Matzdorf, B., Sattler, C. and Alarcon, G.C., 2015. Intermediaries to foster the implementation of innovative land management practice for ecosystem service provision - A new role for researchers. *Ecosystem Services*, 16, pp.192–200

Shannon, C.E. 1948. A mathematical theory of communication. The Bell System Technical Journal, 27, pp. 379 – 423.

Simpson, E.H. 1949. Measurement of diversity. *Nature.* 163, pp. 688

Sitas, N., Prozesky, H.E., Esler, K.J. and Reyers, B., 2013. Opportunities and challenges for mainstreaming ecosystem services in development planning: perspectives from a landscape level. *Landscape Ecology*, pp. 1–17.

Steiner, A., McCormick, J. and Johnson, I., 2004. How much is an Ecosystem Worth? Assessing the economic value of conservation, The International Bank for Reconstruction and Development/THE WORLD BANK.

Stephenson, J. 2008. The cultural values model: an integrated approach to values in landscapes. *Landscape Urban Plan.* 84, pp. 127-139.

Tabachnick, B. G. and Fidell, L. S. 2001. Principal components and factor analysis. In using multivariate statistics (4th ed., pp. 582‑633). Needham Heights, MA: Allyn & Bacon.

TEEB Foundations, 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London and Washington D.C.

The Millennium Ecosystem Assessment (MA). 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington D.C. World Press Institute

Tran Ngoc Cuong. 2015. Ramsar Information Sheet of U Minh Thuong National Park, Vietnam. Available online at: https://rsis.ramsar.org/ris/2228

Tran Triet. 2002. Restoration of vegetations in U Minh Thuong National Park after the fire in March-April 2002. Report in the workshop on Restoration of U Minh Thuong National Park. HCMC: June 2002. (In Vietnamese)

U Minh Thuong National Park (UMT NP). 2013. Findings on an Avifauna Inventory in U Minh Thuong National Park. Unpublished report to GIZ, Kien Giang, 2013. (In Vietnamese)

Verburg, R., Selnes, T. and Verweij, P., 2016. Governing ecosystem services: National and local lessons from policy appraisal and implementation. *Ecosystem Services*, 18, pp. 186–197

Voss, A., Denisovich, I., Gatalsky, P., Gavouchidis, K., Klotz, A., Roeder, S. and Voss, H., 2004. Evolution of participatory mapping GIS. *Computers, Environment and Urban Systems*. 28 (6), pp. 635-651

Wainger, L. and Mazzotta, M., 2011. Realizing the potential of ecosystem services: A framework for relating ecological changes to economic benefits. *Environmental Management*, 48(4), pp. 710–733.

Ward, J.H., 1963. Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association* 58, 236.

Waters, R.D., Lusardi, J. and Clarke, S., 2012. Delivering the ecosystem approach on the ground – an evaluation of the upland ecosystem service pilots. National England Research Report, Number 046

Whittington, D. 1998. Administering contingent valuation surveys in developing countries. *World Development*, 26 (1), pp. 21-30.

Whittington, D. Briscoe, J., Mu, X. and Barron, W., 1990. Estimating the willingness to pay for water services in developing countries: a case study of the use of contingent valuation surveys in Southern Haiti. *Economic Development and Cultural Change*, pp. 293-311.

Chapter 4

Institutional and Legal Aspects of Ecosystem Services

CONTENTS

4.1 The Opportunities

Since the publication of Costanza *et al*., (1997) on the values of the world's ecosystems, the scientific community has witnessed a tremendous increase in ES related publications. In the beginning, a number of researchers were dedicated to building the knowledge base of ES regarding valuing them, within which the Total Economic Values (TEV) concept was one of the most widely accepted and applied analytical frameworks (TEEB 2010). The ultimate goal of ES is to improve human welfare and benefits. Findings from assessment, evaluation, mapping, *etc.* practices merely would be an academic exercise if they were not integrated into policies, thereby directing the way forward to improve the environmental conditions for humans (Hauck *et al*., 2013)

Despite many efforts carried out under this theme(see for instance, Cowling *et al.*, 2008; Daily *et al.*, 2009) there still exist major gaps between the scientific research and real world applications. Schleyer *et al*., (2015) revealed the opportunities and challenges in mainstreaming the ES concept in the European Union (EU) context. Similarly, Sitas *et al.*, (2013) highlighted key challenges in carrying out the task in South Africa, such as the vagueness of the notion, constrained budget, and insufficient coordination between different agencies. Others contributed by looking at theoretical drawbacks of the ES concept itself (Schroter *et al*., 2014; Seifert-Dähnn *et al*., 2015).

To help narrow the gap between academic exercises and real-world applications, this chapter seeks to explore the legal and institutional aspects of the ES approach using results from case study No. 1 in Chapter 3 in the evaluation of PRRC area (Loc *et al.*, 2016). These findings, besides representing the livelihood supporting capacity of the land, also detected the limitations of the current land pricing system in capturing the real values of the resources. However, because the market values of land parcels are governed by a complex system of legal regulations in Vietnam, it is of importance to review all of the related legislative documents to constitute the institutional and legal feasibility of any recommendations for improvement.

Within this chapter, the author targeted the following objectives:

(1) to demonstrate the limitations of Vietnam's current land pricing system in representing natural resources values;

(2) to explore opportunities to incorporate the ES concept in the land valuation policies through critical reviews of the related legislative documents;
(3) to provide a brief literature review about the most recent achievements in mainstreaming the ES concept into policy planning and decision making;
(4) And to suggest and justify the inclusion of an ES-based index as a complement to the current land pricing system within the Vietnamese context.

4.2 Review Methodology

The review section addresses two distinctive categories of literature: legal documents and scientific publications. The first category includes laws, regulations, decrees and national strategies that are relevant to land pricing system and natural resources management of the research area as well as the whole country. The second category focused on scientific publications related to the inclusion of ES information in decision making and policy planning.

4.2.1 Legal documents

Land rental data, together with other information (demographic, cultivation costs, crop yields, *etc.)* were collected through the field survey [(1)]. In general, the rental varies with different communes and is mainly governed by the provincial land pricing regulation issued by the People's Provincial Committee of Kien Giang in 2015. This regulation acts as a guideline for land use related civil actions such as purchase, acquisition, taxation, and leasing. The legal references of this document include the National Law of Land (hereinafter the Land Law), Government Decree on Land Pricing (hereinafter the Government Decree), the Circular of the Ministry of Natural Resources and Environment (hereinafter the MONRE Circular) and Kien Giang Provincial Resolution of Land Price Table (hereinafter the Provincial Resolution), all of which constitute the legal grounds for evaluating any given land parcel with respect to its prescribed use.

The review of these documents serves two purposes: (i) to analyze the most relevant legal papers for pricing and evaluating land resources, concentrating on regulations and articles that are likely to, explicitly or implicitly impact the ecosystems or ES; and (ii) to reveal challenges and

opportunities of integrating the ES concept into the legal framework in the future. The review was carried out using qualitative and deductive text analysis. Our analysis particularly focused on the articles' objectives, the responsibilities of the Central and Provincial Municipalities in developing land prices and regulating valuation methods for individual land parcels. Articles mentioning ES-related terminologies both directly and indirectly were also identified to reveal how the natural land resources values were perceived by the government through the pricing lens.

Besides the documents above, the author expanded the review to three national regulations related to natural resources management. These documents include the Guiding Principles in the (Communist) Party Resolution (Doc no. 24 – NQ/TW), the National Green Growth Strategy in the period 2011 – 2020 and the National Strategy for Environment Protection to 2020. These documents were referred to in the Global Synthesis Report for ES by the United Nations Environment Program (UNEP, 2015). This report is the result of the four-year Project for ES (ProEcoServ) that had the goal of "*piloting the bundling of ES, and the integration of ES approaches into resources management and decision making*" in Vietnam and three other countries including Trinidad and Tobago, Chile and South Africa.

4.2.2. Scientific papers

In addition to the legal documents, scientific publications addressing the integration of ES concepts into decision-making and policy planning were also analyzed. Initially, the following keywords *evaluation, pricing, integration, legislation, land use management,* and *policy* (for each and every query, the term ES was added) were fed into the "Abstract, title, keywords" field to search for manuscripts using the ISI electronic databases. Given the main focus of this paper, the number of articles was extensively narrowed down using two criteria. The first one was directed to capture the most up-to-date knowledge, whereby only studies published in the last ten years were considered. Some exceptions to this chronical criteria, however, were given to notable findings found from the references**.** Secondly, research that only focused on technical aspects of ES such as evaluation or mapping were also disregarded during the screening of abstracts and contents. This exclusion was used to focus the content on institutional and legal issues.

4.3 Important findings

4.3.1 Land Prices versus ES Values

The effective land prices regulated by the Kien Giang Government (2015) have not established a dedicated name and prescribed price for PRRC lands. Rather, these areas are typified as *Annual Crop*, similar to rice and other vegetable crops which, in principle, are valued by their geographical attributes. Table 4.1 shows different typologies of land use and their averaged prices established by the Provincial Regulation (Kien Giang PPC, 2014).

Table 4.1 Land prices in An Minh District

Locations	Perennial crop	Annual crop	Aquaculture	Productive forest	Residential areas
Thu 11	13,181	12,272	Not available	6,820	113,121([b])
Others	12,272	11,820	10,910	6,820	47,700([c])

(a) The values have been converted into USD. The ratio is taken at 1 USD = 22000 VND
(b) Thu 11 is the capital town of the An Minh district
(c) The presented values are the algebraic mean from the typical prescriptions in the provincial regulation.

The land prices in the capital town of Thu 11 are about 10 % higher than the overall prices. For residential areas, the identification of prices includes the most extensive information, *e.g.*, relative locations, distances to rivers, national highways, *etc*. This type of land is, however not the main concern of this paper. Fig. 4.1 illustrates the spatial distribution of the values from Table 4.1.

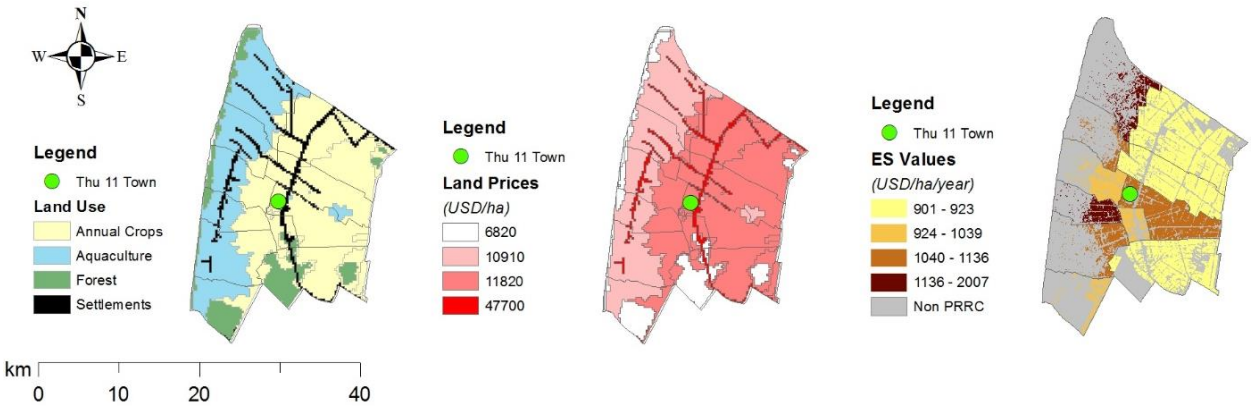


Fig. 4.1 Land use classes of An Minh district and their respective prices

It could be easily recognized that the existing land prices scheme has essentially failed to depict the geographical patterns of land productivity, illustrated by economic values of ES. More specifically, communes with the highest rice yield also bear the highest rentals due to the

historical predominance of rice crops. However, the situation has substantially changed following the adoption of PRRC where the less rice-friendly and cheaper lands could, in fact, generate greater incomes. These dynamic phenomena are not visible in Fig. 4.1, alluding to the need for progressive indicators that could effectively monitor the variations of land values. To put it differently, the added values of the ES-based approach compared to the current land pricing lie in (1) the representability of the land profitability using ES unit values and (2) the demonstration of human-nature relationships through livelihood-sustaining functions. Ultimately, though more resource-consuming, the inclusion of ES information in land evaluation practices should be opted for for a more integrated and sustainable land use policies.

4.3.2 Legal Framework of Land Pricing

This section investigates the hierarchy of relevant legal documents. Within the following discussions, the term "land prices" refers to the unit prices of lands that are, in general, determined by the Government on the respectively designated uses, such as agricultural, residential, *etc*. via a comprehensive system of legislations. The land prices are established to provide official preferences for related civil acts such as acquisitions, compensations, inheritances, *etc.* Within the hierarchy system of relevant documents, The Land Law issued by the National Assembly (Doc No 45/2013/QH13) and the Government Decree (Doc No 44/2014/ND-CP) have the highest legal validity. Based on the Land Law, the MONRE Circular (Doc No 36/2014/TT-BTNMT) was issued in 2014 to instruct land evaluation methods, provincial land price list adjustments, specific land pricing methods and land pricing consultancy practices. Finally, at the local level, the Provincial Municipalities (known as the People's Committees in the Vietnamese administrative system) develop the five-year Provincial Resolutions to apply the general regulations of the documents above to the local contexts. Table 4.2 summarizes relevant chapters, articles, and paragraphs of the legal documents associated with land pricing.

Table 4.2 The legal framework related to land pricing

Glossary: C = Chapter; A = Article; P = Paragraph

Document	Attributes	Relevant contents
The National Land Law (Doc No 45/2013/QH)	Nationally applicable Issued by The National Assembly in November 2013 based on the National Constitution.	1) C1 – A4: The land is publicly owned and the Government plays the role of ownership representative. The Government approves the citizen's rights to use. 2) C1 - A10 - P1: Classification of agricultural land uses. 3) C1 – A14: The land use is decided by the Government. 4) C1 – A14: The Government regulates principles and methods to value the land. The Government issues the land price table and regulates specific land prices. 5) C1 – A38 - 40 – P1.b, c and d: Land Use Planning at National level (Provincial and District levels, respectively) includes **natural and socio-economic conditions**, current **land use conditions**, **land potential**, **sectoral land use demands** and land use related **scientific advancements**. 6) C8 – A112 – P1.d: Lands with similar use and **profitability** from similar use should have the same prices. 7) C8 – A113: The Government issues the land price. This land price table is subjected to change should the land market price increase or decrease by at least 20% compared to the minimum regulated price. The land price table is established once in 5 years with respect to land uses and geographical areas.
The Government Decree (Doc No 44/2014/ND-CP)	Nationally applicable Issued by the Government of Vietnam on May 2014 based on the National Land Law	1) C1 – A4 - P3: *Income method* is the method of land valuation using the ratio between **averaged annual net income** on a unit area and averaged annual bank rate at the state owned bank in the respective province that has the highest rate. 2) C1 – A5 – P3.c: *Income method* is used to value land parcel of which incomes, costs from land use can be identified. 3) C2 – A6: Land price table establishment must be based on A.112 of the Land Law. 4) C2 – A7: Regulates minimum prices for every prescribed land use (5 classes for agricultural use and 6 classes of non-agricultural use) 5) C2 – A8 – P1.b: Inspection, synthesis and analysis of land market prices, **natural and socio-economic conditions**.
The MONRE Circular (Doc No 36/2014/TT-BTNMT)	Nationally applicable Issued by the Ministry of Natural Resources and Environment (MONRE) on June 2014 based on the National Land Law and the Government Decree.	1) C1 – A5 – P1: Using *Income method* to value agricultural lands: * For annual crop, aquaculture, or salt production lands, the average annual income is calculated from the **averaged amount of income from production** in the most recent 3 continuous years. * For perennial crop, productive forest lands, the average annual income is calculated based on the **annual income, periodical income, or onetime-income**. 2) C1 – A7 – P3: Using *Correction factor method* for land valuation. This correction factor is identified based on the popular land market price with the consideration of specific **natural and**

		socio-economic conditions at the respective local area with references to the established land price table. 3) C2 – A9 – P2: Based on the **local conditions**, the Provincial People's Committee decides to increase (or decrease) the land parcel price having advantages (or disadvantages, respectively) in considering local conditions such as area, geometric shapes, **profitability**, and other **price influencing factors**. 4) C2 – A15 – P1: Identify the land location in the land price table. For agricultural land, the location is defined based on the **crop productivity**, infrastructure conditions, and other **business related advantages**. Besides, distances between the land and the residences, processing facilities and markets must be considered as well. 5) C2 – A16 – P1.b: Inspection and gathering of information regarding **natural and socio-economic conditions**, and **land use management which influences the land price**.
The Provincial Resolution (Doc No 90/2014/NQ-HDND)	Provincially applicable Issued by the People's Committee of Kien Giang Province on December 2014, followed by the issuance of Kien Giang Provincial Land Price Table in 2015. These provincial documents are based on National Land Law; the Government Decree and the MONRE Circular.	Issued by the People's Committee of Kien Giang Province on December 2014, followed by the issuance of Kien Giang Provincial Land Price Table in 2015. These provincial documents are based on National Land Law; the Government Decree and the MONRE Circular. 1) A1 – P2.b: Agricultural lands located along the National Highways have their prices multiplied by 1.3 times compared to the established agricultural land price, respective of communes (except for the Rach Gia city) 2) Annex 1 – 15 The Land Price Tables of 15 districts, in which, Annex 4 presents those of An Minh district.

Regarding the ES related terminologies, the author initially searched for words and phrases explicitly mentioning ecosystem, services, functions, or ES; but this effort was in vain with zero hits. This result was not surprising given the developed country origins of the terms versus the developing country contexts of the study. The concept is scientifically complex and has been described as "esoteric" and "unrealistic" (Sitas *et al.*, 2014). As such, they are very unlikely to be used in legal documents that ultimately target the general public application in a developing country. This issue is compounded by the very different political and institutional systems installed in the west, compared to Vietnam. In the subsequent effort, terminologies that could indirectly or implicitly deduce the connections between resource considerations and the pricing system were identified. The results from the second review were presented with bold texts in Table 4.2. Keywords such as profitability, productivity, land potential and land use conditions

could reflect the concern of the governments (Central and Provincial) regarding land resource values (or the ES associated with the land). Similarly, the current Income method of land valuation utilizing the annual revenue from the land to calculate the land prices demonstrates recognition of the land capacity in providing human benefits.

Needless to say, within these terminologies, provisioning, regulating services that exceed the land boundaries or the cultural services with intangible benefits were essentially neglected (TEEB, 2010). Moreover, within more than 300 pages of legal documents reviewed, the results presented in Table 4.2 are relatively minimal and essentially invisible among hundreds of other articles and regulations. This imbalance suggests that within the current land pricing system, the policy makers might not pay sufficient attention to the natural aspects of the land.

4.3.3 ES Integrated National Legislations

The ProEcoServ is a four-year project initiated by the UNEP that aims at the evaluation and mainstreaming of ES concepts into policy planning and decision making with case studies done in Vietnam and three other countries. With respect to the Vietnam case study, the success of the project has been recognized both at the local and national levels, with some key contributions. Firstly, the application of supporting tools (evaluation and mapping), organization of policy dialogues and consultation to raise awareness for policy makers, and more importantly, the mainstreaming of ES concepts into land use planning of the National Park of Ca Mau were successfully implemented. Secondly, at the national level, the concept has begun to be recognized and mentioned in three national legislations. The inclusion of ES information in these documents and remarks from the ProEcoServ are summarized in Table 4.3.

Table 4.3 ES integrated national legislations

Glossary: C = Chapter; A = Article; P = Paragraph

Document	Attribute	Relevant contents
The (Communist) Party Resolution (Doc No 24 – NQ/TW)	The Resolution was issued by The Central Executive Committee of Communist Party in 2013 regarding the proactive response to climate change and improved natural resources	The Resolution was issued by The Central Executive Committee of Communist Party in 2013 regarding the proactive response to climate change and improved natural resources management and environmental protection C2 – P1: Principles and Objectives "Natural resources are the **National Assets**, resources and important natural capital for country development.

	management and environmental protection	Therefore, natural resources need to be **fully assessed, prized and accounted** for in the national economy" C3 – P2.b. Specific Objectives in resource management "Evaluate, improve **ES**, aesthetics, genetic resources" ProEcoServ remarks: The Resolution plays an important role in guiding different stakeholders (ministries, sectors) in integrating the concept of ES and Natural Capital in the planning processes.
National Green Growth Strategy in the period of 2011 – 2020	The Strategy was developed by Ministry of Planning and Investment (MPI) and approved by the Government in 2012 with Decision no 1393/QĐ-TTg	The Strategy was developed by Minstry of Planning and Investment (MPI) and decided by the Government in 2012 with Decision no 1393/QĐ-TTg C3 – P8.d: Promote Green Economy to create more jobs, increase income, enrich **natural capital** • Studying and issuing economic and financial policies of restoring and developing **natural capital resources** • Mobilizing and encouraging all economic sectors to invest in **ES infrastructures**, conservation areas and restoration of degraded ecosystems • Formulating **green accounting system** through the pricing of **natural capital resources** • Restoration and development of **natural capital** ProEcoServ remarks: The strategy plans to achieve a low-carbon economy and enriches natural capital which will become the principal in sustainable economic development.
National Strategy for Environment Protection to 2020, vision to 2030	The Strategy was developed by MONRE and approved by the Government in 2012 with Decision No 1216/QĐ-TTg	The Strategy was developed by MONRE and decided by the Government in 2012 with Decision No 1216/QĐ-TTg C2 – P3.d: Specific objectives • Investigating and conducting assessment to identify the degradation and shrinkage of **natural ecosystems** • Increasing the degree of rehabilitation of **natural ecosystems** to strengthen their climate change resilience • Developing **Payment for ES** (PES) ProEcoServ remarks: This strategy seeks to achieve the objectives of rehabilitating of regenerating degraded ecosystems.

Source: Global Synthesis Report of the ProEcoServ, UNEP, 2015

The inclusion of relevant keywords, *e.g., ES, PES, Ecosystem* and *Natural Capital* in national legislative documents and the combination of the natural resources protection objectives with sustainable economic development strategies constitute substantial evidence indicating the government's recently developed recognition of the importance of natural resources conservation

as well as the ES itself. Also, these could signify the institutionalization of the terminologies that could open up opportunities for more ES-based approaches in natural resources management agendas.

4.3.4 Scientific papers brief review

The evaluated publications include not only papers related to land pricing but also those related to ES integrated policies and decision makings. The intent of this review was: (i) to broaden the discussion beyond the boundary of the case study; and (ii) to provide a brief update on how far the ES concept has gone in becoming the mainstream in decision making. It is first noteworthy that our keywords (policy integration) resulted in far fewer hits than "valuation" and "mapping." For instance, using the *ScienceDirect* database (http://sciencedirect.com), the search for "policy integration" as keywords for "Title, Abstract, and Keywords" yield only three pages of result pages compared to 13 for both "valuation" and "mapping." It appears that the "valuation" and "mapping" are still predominant in the scientific literature. Presented herewith in Table 4.4 are some of the most recent and notable contributions.

Table 4.4 ES Integrated policies found in the literature

Literature	Research area	Contents
Schleyer *et al.*, 2015	EU	EU initiatives: Biodiversity Strategy to 2020, Green Infrastructure Strategy; the Blueprint to Safeguard Europe's Water Resources
Mascarenhas *et al.*, 2015	Portugal	Key terms were used in the General Guidelines for the Design of Regional Spatial Plans and Strategic Environmental Assessment (SEA) policies.
Schaefer *et al.*, 2015	United States of America (USA)	Federal agencies initiatives: Markets for ES by Department of Agriculture (USDA), Benefit assessment methods; science-policy analysis by the United States Environmental Protection Agency (USEPA) and the establishment of the National ES Strategy Team (NESST) of the US Forest Service, *etc.* which were directed and supported by the White House Offices (Box 4.1)
Hirokawa 2011	USA	The relevance of the ES perspective to environmental regulation at the local government level was explored. Noteworthy regulations include the Standard Zoning Enabling Act (SZEA); the "pollution location" approach; the Smart Growth and Sustainable Development schemes, *etc.* This manuscript also highlighted some relevant imbalances between national and local environmental laws, thus emphasized the roles of local government in achieving environmental goals.
Thompson, B.H. 2005	USA	One of the major aims of the USEPA's Office of Research and Development is to help policy makers recognize the impact of their

		choices on ES. This agency issued an Ecological Benefits Assessment Strategic Plan in 2006 to promote better measurements and acknowledgments for ES values. The ES concept has also been incorporated into federal laws such as the Endangered Species Act or the Clean Water Act.
Salzman *et al.*, 2001	USA	Examples of actions taken by the states and local governments to preserve watershed lands regarding water quality and flood control: • Dale Country, Florida imposed 3% surcharge on water bills to fund land acquisition and watershed protection • Portland, Maine purchased properties within the main reservoir periphery area. The city also funds "Plant Grant Program" to support private land owners to establish buffers for erosion control • Rochester, Minnesota had started a program paying riparian farmers to preserve buffer zones along key water bodies to protect water supplies.
Cox *et al.*, 2013	USA	The U.S. President issued Executive Order calling departments to safeguard the health of the environment in 2009. As a response, 207 programs and projects from federal agencies addressing ES have been implemented. Among which, USDA; USEPA and Department of Interior (DOI) contribute the most. Research types include biophysical and resource management, valuation and market, *etc.*
Scarlett and Boyd 2013	USA	Several federal agencies have increasingly focused on ES frameworks in setting priorities and identifying geographic boundaries for resources management, *e.g.*, the Bureau of Land Management (BLM); The Natural Resource Conservation Service (NRCS). Besides, The US Forest Services also explored private stewardship opportunities with PES-based initiatives such as Forests to Faucets program.
Greenhalgh and Hart 2015	New Zealand	Initiatives taken by government and business: Resource Management Act (RMA – 1991), Regional Policy Statements (RPS), Corporate Ecosystem Review (2012), Sustainable Business Council (SBC-2012) and Corporate ES Review (WRI – 2012).
Pittock *et al.*, 2012	Australia	The term ES has been increasingly used since the early 2000s. It now appears in most environmental policy documents and environmental legislation such as land use allocation, regional natural resources management, water management, *etc*.
You. (in press)	China	The importance of ES has also been recognized by the Chinese environmental law with a multi-level legal system that facilitates effective performance evaluation, liability for the disruption of the ecosystem.
Toledo *et al.*, (2016)	Columbia	The country recently witnessed a legal case related to environment disruption which was handled using the results from an ES evaluation study.
UNEP 2015	South Africa, Chile, Trinidad and Tobago, Vietnam	Integration of ES concept into Macro-economy Policy and Land Use Planning. The "success stories" included the launch of Ecological Infrastructure Partnership (South Africa), a natural capital accounting framework (Trinidad and Tobago), a decision support tool (Chile) and

		recognition of natural capital and ES under three national legislations (Vietnam).
Stępniewska *et al.,* (2016)	Poland	Ecosystem protection was regulated by the ACTS of the Environmental Protection Law (27th April 2001); Planning and Spatial Management (27th March 2003), Nature Conservation (16th April 2004), Protection of Agricultural areas (3rd February 1995).
Costa (in press)	Brazil	Brazil does not have dedicated laws for ES, but 50 % of the states have created the strategies called a tax on goods circulation and provisioning services, ICMS. These strategies seek to compensate municipalities by restricting land use for nature conservation or environmental protection.

Apart from You. (in press), the majority of reviewed literature relates to the integration of ES or natural capital notions in the environment and natural resources related strategies (Schleyer *et al.,* 2015; Sitas *et al.,* 2013) or sectoral programs of government agencies (Schaefer *et al.,* 2015; Greenhalgh and Hart 2015). The prospects of including ES information in environmental policies are various, for instance, it can facilitate effective communication among decision makers from different sectors (Maes *et al.,* 2013); it can contribute to the accounting and reporting systems of natural capital stocks regarding their economic and non-economic values (Hauck *et al.,* 2013); *etc.* There are, however, a number of challenges in carrying out the tasks, such as the absence of widely accepted terminologies (Sitas *et al.*, 2013), readily applicable measurement methods (Ruhl and Gregg 2001), consideration of intrinsic values of human-nature relationships, and the encouragement of exploitive behavior (Schröter, *et al.,* 2014). Promoting the prospects and countering arguments, therefore, become crucial in realizing the ES concept as a major driving force for environmental policy-making (McCauley 2006; Schroter *et al.,* 2014; Matzdorf & Meyer 2014). In addition to science, social science, and engineering contributions, notable in this trend is the body of work by legal scholars highlighting the reciprocal relationships between the ES concept and environmental laws, both federal and local (Hirokawa 2011), or conversely, identifying mismatches (Ruhl and Gregg 2001).

Box 4.1 The White House October 2015 Directive

The United States of America (USA) could be one of the most advanced nations, regardless of biophysical measurements, to have integrated ES into natural resources management. More specifically, the US federal policy made large steps forward in this regard with the October 2015

White House Directive (hereinafter the Directive) entitled "Incorporating ES into Federal Decision Making" from the Office of Management and Budget (OMB), the Office of Science and Technology Policy and the Council on Environmental Quality (CEQ) (Executive Office of the President 2015). This document directs federal agencies to (1) develop and institutionalize policies to promote consideration of ES in planning, investments and regulations and (2) implement policies to integrate ES assessments at the appropriate scales, into relevant programs by their statutory authority. While others are struggling with the definitions or stagnated with the unjustified added values of ES to their existing policies, the Directive has become a lighthouse, explicitly asking federal agencies to (1) describe the current state of practice, challenges in consideration of ES in decision making, and (2) develop their work plans to move forward with the integration goals, exemplifying planned policies, projects, *etc.* These efforts are supported by the implementation guidance from CEQ and OMB, in collaboration with subject-matter experts, and undergo an external peer review, public comment, and interagency review processes. Ultimately, the three Offices above and Council will play the leading roles in facilitating interagency coordination, including supporting agencies to successfully integrate ES in their decision making. Simultaneously, these steering offices will cooperate with external work groups to develop long-term strategies for integration of ES in decision-making.

4.4 Discussions

4.4.1 The Opportunities of ES

The valuation and mapping results in of ES associated with PRRC (Loc *et al.*, 2016) were the main inspiration to develop this paper in an attempt to explore the findings beyond the case study boundaries. More specifically, we strove to explore the opportunities to utilize findings from an ES evaluation study in the context of the research area initially and all of Vietnam in a broader sense. To achieve such goals, critical review of relevant legal documents associated with land pricing and natural resources management was undertaken to reveal opportunities to integrate and mainstream the ES concept in future regulations. More specifically, the concern of *"socio-economic conditions, current land use conditions, land potential, sectoral land use demands and land use related scientific advancements"* during the development of land use planning at the national and

provincial levels could be effectively addressed with the help of an ES evaluation framework. Besides, the ES fundamentals can resonate with keywords such as *profitability, price influencing factors,* or *business-related advantages* that have been mentioned in the legal documents. This paradigm convergence can serve as a starting point to facilitate discussion with policy makers and explore opportunities to improve the current land pricing systems with ES information. Last but not least, the expectations are reinforced by the institutionalization of the natural capital concept which explicitly addresses ES, Natural Capital and PES [(2)] in three distinctive National Legislations.

4.4.2 Introduction of ES Index

Given the complexity of a legal framework that is horizontally and vertically interlinked, in the short term, the inclusion of an ES index as an additional reference for the provincial land price tables can be suggested. This inclusion could offer added values in the representation of the land profitability; an information tool for decision makers; and provide avoided costs of not having to revise the overall land use classification system, and establish necessary foundations to promote the application of ES in the future.

At first glance, there are noticeable similarities between the ES index approach and the income method, currently employed by the land pricing system given the economic background of the two. The ES-based, however, is different from the latter approach in separately accounting for anthropogenic and natural contributions. For instance, Loc *et al.,* (2016) conceptualize a scenario within which humans and nature join forces to create benefits, in this case, the crop yields. As such, the values of nature's contribution is captured by subtracting the total income with the human investments (associated farming costs), hence a more precise representation of land *profitability* is determined than through the income method, which relies on the averaged values of three-year total revenue. Also, information of the related costs, together with other social factors, can be further analyzed to explore other aspects of the PRRC system such as people's experience and willingness to implement a new cropping system that can influence land use decisions (Loc *et al.,* 2016).

The non-negativity of the ES values for the PRRC signifies land values are underestimated, but this does not currently translate into a negative impact on stakeholders, such as increased land rentals, taxes, *etc*. Conversely, the introduction of an ES index should be recognized as an informative tool to help decision makers better acknowledge the real land profitability such that, inefficient land use decisions and unvalued compensations for agricultural land acquisitions can be substantially reduced.

Cases such as PRRC are largely recognized at a local level to cope with adverse natural conditions such as floods, droughts, salinity intrusion, *etc*. These conditions, although significant, are localized in nature where forth, the generalization of their adaptive measures into the national land use classification cannot be justified. Another option, probably more economical, is to account for the disparities between local adaptive and the currently regulated usages (PRRC vs. annual crops in the case study) using *correction factors*. The second approach can save time and resources by not having to modify the entire legal system and feed useful observatory information to decision making.

Finally, in the long term, the ES-based index benefits could be recognized even beyond the land pricing system. For instance, with the full development of an ES observatory system and full-scale monitoring system, appropriate adaptive measures could be implemented at a higher level of confidence. This scenario could only be realized by the government's full recognition of the importance of ES, as demonstrated through consistently resourced management institutions (Pittock *et al.*, 2012).

4.4.3 Future Visions

With the upsurge of ES context applications and the increasingly demonstrated benefits of ES, many would believe in a bright future of ES accounting (Hauck *et al.,* 2013; Matzdorf and Meyer 2014; Schleyer *et al.*, 2015). Others such as Abson *et al.,* (2014); Kull *et al.*, (2015) and Schroter *et al.,* (2014) are skeptical given the vagueness and theoretical approach of the concept in valuing nature and the lack of practical guidelines.

The integration of ES information predominantly takes place in natural resources preservation related policies. As such, the concept is more likely to be kept in the green and anti-development

zone which is limiting to the full scope of ES application (Hauck *et al.*, 2013; Sitas *et al.*, 2013). Also, the integration efforts can be challenging given the silos-operation between policies making and executing agencies (Sitas *et al.*, 2013).

The novelty of this research, therefore, lies in the recommendation to take one step forward with the legalization of the concept, specifically in Vietnam, but possibly in other Southeast Asian countries too. This approach, although theoretical, could offer some positive prospects. Firstly, being legalized, definitions and classifications of terminologies, as well as practical guidelines, would be standardized by legal frameworks. Henceforth, the prevalent critiques of ambiguity and the lack of practical guidance (Seifert-Dähnn *et al.*, 2015; Schroter *et al.*, 2014; Albert *et al.*, 2014; Verburg *et al.*, 2016) could be essentially countered. Plus, given the recognition of legal standing, ES could be made a more public friendly concept. Once achieved, ES could substantially stand out from other environmental keywords, for example, Ecological Footprint, the 2001 Environmental Sustainability Index; or Ecological Deficit (Wackernagel & Rees. 1996; Wackernagel & Onisto. 1997).

4.5 Conclusions

This chapter was developed following the findings from case study No. 1 within Chapter 3 about the ES economic values and spatial distribution of an adaptive cultivation system in the Mekong Delta. The original motivations behind the presented efforts are to explore opportunities in utilizing the results from ES evaluation studies to improve the current decision-making context. Accordingly, a literature review of relevant legal documents and some noteworthy scientific publications related to ES integrated policies was conducted. As a result, the subsequent concluding remarks were crafted:

(1) In the short term, the inclusion of an ES index is an appropriate approach given the legal and institutional contexts of the research area.

(2) In the long term, more ES related policies could be expected due to the recognition of the Central government about the importance of the concept in sustainable economic development.

(3) The US's October 2015 Directive could provide a good example of how governmental agencies might join forces to provide sustained leadership around ES. However, fundamental differences such as political and institutional conditions should be thoroughly addressed.

(4) The majority of ES mainstreaming efforts relates to the institutionalization of the concept into environment preservation policies. This chapter, however, suggests a different approach, which is legalization using correction factors to complement the current pricing systems. This method could essentially address two critical challenges in ES mainstreaming: ambiguity of definitions and the need for detailed implementation guidelines. On the other hand, better acknowledgment from the public for natural capital and ES concepts could also be recognized during the implementation process.

Notes

(1) A total of 50 households were surveyed via face to face interviews using semi-structured questionnaires. The households were purposely chosen based on their tillage practices in recent years. Hence, the surveyed respondents only consisted of those with certain experience (at least five years) with PRRC which cover all 11 communes throughout the landscape of the An Minh district. The interviews started with an introduction to the ecosystem concept, ES and the purpose of the research. Respondents were then asked about basic demographic characteristics, *i.e.,* gender, age, education, *etc*. The next section of the interview explored aspects of PRRC such as agricultural calendars, seed selection, and schedule for each crop. Finally, the associated costs (fixed and variable), as well as averaged yields and benefits in recent years, were discussed. Each interview took approximately 40 - 50 minutes.

(2) ES, Natural Capital, and PES, albeit closely related are distinct. Especially for ES versus PES, several misconceptions emerge. In reality, the payment amount of PES is rarely similar to the estimated values of ES (Schröter *et al.,* 2014). Similarly, Natural Capital can be defined as the world's stocks of natural assets which include geology, soil, air, water and all living things, within which, ES accounts for the human-beneficial components.

References

Abson, D.J., von Wehrden, H., Baumgartner, S., Fischer, J. and Hanspach, J. et al. 2014. Ecosystem services as a boundary object for sustainability. *Ecological Economics*. 103, pp. 29 – 37.

Albert, C., Aronson, J., Fu¨rst, C., Opdam, P., 2014. Integrating ecosystem services in landscape planning: requirements, approaches, and impacts. *Landscape Ecology*, 29(8), pp. 1277–1285.

BCS (Bayer Crop Science). 2015. Positive impacts of Arize-BTE1 toward prawn cultivation in Prawn-Rice Rotational Crop areas in Bac Lieu, Ca Mau and Kien Giang. From: http://www.cropscience.bayer.com.vn/vi-VN/News-Event-Program-Promation/

Costa, B.S., 2016. The role of legal aspects of Ecosystem Service in Brazil to achieve the sustainable development. *Ecosystem Services*, p.1.

Costanza, R., Arge, R., Groot, R. De, Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V, Paruelo, J., Raskin, R.G., Suttonkk, P. and van den Belt, M., 1997. The value of the world ' s ecosystem services and natural capital. *Nature*, 387(May), pp.253–260.

Cowling, R.M., Egoh, B., Knight, A.T., O'Farrell, P.J., Reyers, B., Rouget, M., Roux, D.J., Welz, A., Wilhelm-Rechman, A., 2008. An operational model for mainstreaming ecosystem services for implementation. *Proceedings of the National Academy of Sciences of the United States of America*, 105(28), pp.9483–9488.

Cox, L.M., Almeter, A.L. and Saterson, K.A., 2013. Protecting our life support systems: An inventory of U.S. federal research on ecosystem services. *Ecosystem Services*, 5, pp.163–169.

Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: Time to deliver. *Frontiers in Ecology and the Environment*, 7(1), pp.21–28.

Executive Office of the President, 2015. Memorandum for Executive Departments and Agencies: Incorportating Ecosystem Services into Federal Decision Making. Executive Office of the President, Washington, DC.

Greenhalgh, S. and Hart, G., 2015. Mainstreaming ecosystem services into policy and decision-making: lessons from New Zealand's journey. *International Journal of Biodiversity Science, Ecosystem Services and Management*, 3732(June), pp. 1–11.

Hauck, J. , Go¨rg, C., Varjopuro, R., Ratama¨ki, O. and Jax, K., 2013. Benefits and limitations of the ecosystem services concept in environmental policy and decision making: Some stakeholder perspectives. *Environmental Science and Policy*, 25, pp. 13–21.

Hirokawa, Keith H. 2011. Sustaining Ecosystem Services Through Local Environmental Law, 28. *Pace Environmental Law Review*. 760. Available at: http://digitalcommons.pace.edu/pelr/vol27/iss3/4

Loc, H H., Diep, N.T.H., Can, N.T., Irvine, K.N. and Shimizu, Y. 2016. Integrated Evaluation of Ecosystem Services in Prawn-Rice Rotational Crops, Vietnam. *Ecosystem Services*. Elsevier, pp.1–11.

MA (Millennium Ecosystem Assessment), 2005. Ecosystems and human well-being: Synthesis. Island Pres, Washington D.C. World Press Institute.

Maes, J. et al., 20 Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schägner, J.P., Grizzetti, B., Drakou, E.G., Notte, A. La, Zulian, G., Bouraoui, F., Luisa Paracchini, M., Braat, L. and Bidoglio, G., 201213. Mainstreaming ecosystem services into EU policy. *Current Opinion in Environmental Sustainability*, 5(1), pp. 128–134.

Mascarenhas, A., Ramos, T.B., Haase, D. and Santos, R., 2015. Ecosystem services in spatial planning and strategic environmental assessment-A European and Portuguese profile. *Land Use Policy*, 48, pp. 158–169.

Matzdorf, B. and Meyer, C., 2014. The relevance of the ecosystem services framework for developed countries' environmental policies: A comparative case study of the US and EU. *Land Use Policy*, 38, pp. 509–521.

McCauley, D.J., 2006. Selling out on nature. *Nature*, 443(7107), pp.2 7–28.

MONRE (Ministry of Natural Resources and Environment) of Socialist Republic of Vietnam. 2014. Circular on detailed regulations of land pricing methods; land price table development and adjustments and land pricing consultancy.

Circular. No. 36/2014/TT – BTNMT

Muradian, R., Arsel, M., Pellegrini, L., Adaman, F., Aguilar, B., Agarwal, B., Corbera, E., de Blas, D.E., Farley, J., Froger, G., Garcia-Frapolli, E., Gómez-Baggethun, E., Gowdy, J., Kosoy, N., Le Coq, J.f., Leroy, P., May, P., Méral, P., Mibielli, P., Norgaard, R., Ozkaynak, B., Pascual, U., Pengue, W., Perez, M., Pesche, D., Pirard, R., Ramos-Martin, J., Rival, L., Saenz, F., Van Hecken, G., Vatn, A., Vira, B. and Urama, K., 2013. Payment for ecosystem services and the fatal attraction of win-win solutions. *Conservation Letters,* 6, pp. 274 – 279.

Pittock, J., Cork, S. and Maynard, S., 2012. The state of the application of ecosystems services in Australia. *Ecosystem Services*, 1(1), pp. 111–120.

PPC Kien Giang (People's Committee). Decision on land pricing code in Kien Giang province. 2014. Decision. No. 35/2014/QD - HDND

PPC Kien Giang (People's Committee). Resolution on land pricing code in Kien Giang province. 2014. Resolution. No. 90/2014/NQ-HDND

Ruhl, J.B. and Gregg, R.J., 2001. Integrating Ecosystem Services into Environmental Law: A Case Study of Wetlands Mitigation Banking. *Stanford Environmental Law*, 20(365), pp.365–392.

Salzman, J., Thompson, B.H. and Daily, G.C., 2001. Protecting Ecosystem Services- Science, Economics and Law. *Stanford Environmental Law Journal*, 20(309), pp. 309-326

Scarlett, L. and Boyd, J., 2013. Ecosystem services and resource management: Institutional issues, challenges, and opportunities in the public sector. *Ecological Economics*, 115, pp.3–10.

Schaefer, M., Goldman, E., Bartuska, A. M., Sutton-Grier, A., and Lubchenco, J., 2015. Nature as capital: Advancing and incorporating ecosystem services in United States federal policies and programs. *Proceedings of the National Academy of Sciences*, 112(24), pp.7383–9.

Schleyer, C., Görg, C., Hauck, J. and Winkler, K.J., 2015. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. *Ecosystem Services*, 16, pp.174–181.

Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S. and Opdam, P., 2014. Ecosystem Services as a Contested Concept: A Synthesis of Critique and Counter-Arguments. *Conservation Letters*, 7(6), pp. 514–523.

Seifert-Dähnn, I., Barkved, L.J. and Interwies, E., 2015. Implementation of the ecosystem service concept in water management – Challenges and ways forward. *Sustainability of Water Quality and Ecology*, 5, pp. 3–8.

Sitas, N., Prozesky, H.E., Esler, K.J. and Reyers, B., 2013. Opportunities and challenges for mainstreaming ecosystem services in development planning: perspectives from a landscape level. *Landscape Ecology*, pp. 1–17.

Stępniewska, M., Zwierzchowska, I. and Mizgajski, A., 2016. Capability of the Polish Legal System to introduce the ecosystem services approach into the Environmental Management System. *Ecosystem Services*, p. 2212.

TEEB Foundations, 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London and Washington D.C.

The Government of Socialist Republic of Vietnam. 2012. Decision National Strategy for Environment Protection to 2020, vision to 2030. Decision. No. 1216/QD – TTg.

The Government of Socialist Republic of Vietnam. 2012. Decision on the National Green Growth Strategy in the period of 2011 – 2020. Decision. No. 1393/QD – TTg.

The Government of Socialist Republic of Vietnam. Decree on Land Price. Decree. 2014. No. 44/2014/ND – CP

The National Assembly of Socialist Republic of Vietnam. The National Land Law. Law. 2013. No. 45/2013/QH13

The Party Resolution on the proactive response to climate change and improved natural resources management and environment protection. Resolution No. 24/NQ – TW.

Toledo, D., Briceño, T. and Ospina, G., 2016. Ecosystem service valuation framework applied to a legal case in the Anchicaya region of Colombia. *Ecosystem Services*, p.1.

UNEP, 2015. Success Stories in Mainstreaming Ecosystem Services into Macro-economic Policy and Land Use Planning : Evidence from Chile , Trinidad and Tobago , South Africa and Viet Nam,

Verburg, R., Selnes, T. and Verweij, P., 2016. Governing ecosystem services: National and local lessons from policy

appraisal and implementation. *Ecosystem Services*, 18, pp.186–197.

You, M., 2016. Assessment of multi-level legal mechanisms for the protection of ecosystem services in China. *Ecosystem Services*, (15), p.1.

Wackernagel, M., Rees, W., 1996. Our Ecological Impact: Reducing Human Impact on the Earth. The Society Publishers, Forum.British Colombia.

Wackernagel, M., Onisto, L., et al., 1997. Ecological Footprints of Nations: How much Nature do they use? How much Nature do they have? The Earth Council, San Jose,Costa Rica.

Vietnam National Mekong Committee. 2011. Preliminary study on climate change adaptation plan in Kien Giang Province. Final Report.

Chapter 5

Recognizing Ways Forward

CONTENTS

In addition to discussing relevant criticisms of ES and respective counter-arguments, Schröter *et al.*, (2014) also recommended several ways ahead including: utilization of ES as a platform to integrate different worldviews, to promote the biodiversity concept using ES, to find alternatives to monetization such as social-based, biophysical measurements or the combination of both to foster the concept with transdisciplinary processes. Likewise, focus on developing useful guidance documents and assessment databases; promoting stakeholder involvement at various stages including assessment, implementation, and management are also valuable opportunities to enhance the application of ES in shaping future policies (Cowling *et al.*, 2008; Seifert-Dähnn *et al.*, 2015). All of those above constitute a growing body of ES literature in shaping future research questions to improve the application of ES in policy planning processes. As a contribution in this regard, this chapter addresses three relevant methodological mismatches in current ES studies: (1) the lack of consensus, (2) the issue of scales, and (3) the monetization paradox. We also explore opportunities with (4) the emerging conceptual frameworks for ES approach, (5) the integration of ES information in other decision support tools, and (6) the interplay of policy actors.

5.1 Consensus

In chapter 1, the author used the term usually perceived (written in italic) to refer to the fact that neither ES definitions nor their classifications have reached consensus, which constitutes one of the most important barriers in introducing ES knowledge into decision-making processes. In particular, the missing standardized terminologies and practical guidelines have frequently been mentioned as one of the critical shortcomings, both in the theories and practices of ES assessment yet the search for such essentially resembles the *Chimera*[(1)] hunt. Within the body of literature, some definitions and classification schemes are readily available. Table 5.1 summarizes some common definitions and classification schemes of ES found in the literature.

Table 5.1 Definitions and Classifications commonly used in ES

Commonly used definitions	References
Benefits human populations derive, directly and indirectly, from ecosystem functions	Costanza *et al.*, 1997
Benefits people obtain from ecosystems	MA. 2005
Final ES are components of nature directly enjoyed, consumed or used to yield human well-being	Boyd and Banzhaf 2007
Ecosystems contribution to human well-being	TEEB. 2010

Taxonomies	Descriptions and examples	
Provisioning Regulating Cultural Supporting Habitat	**Provisioning**: goods directly extracted from ecosystems (timber, fuel food) **Regulating**: processes that help to maintain the regulations of ecosystem processes (carbon sequestration, pest control) **Supporting**: processes that support the provisioning of other services (soil formation, nutrient cycling) **Cultural**: spiritual welfare (recreational, spiritual, religious) **Habitat**: nursery functions	MA. 2005 de Groot *et al.*, 2002
Adequate resources Protection from threats Socio-cultural fulfillment	**Adequate resources**: food, water, air, energy **Protection from threats**: protection from predators, disease, adverse natural phenomena **Socio-cultural fulfillment**: spiritual contentment, recreation, aesthetics.	Wallace 2007
Rival and excludable Rival and non-excludable Non-rival and excludable Non-rival and non-excludable	**Rival and excludable**: market goods **Rival and non-excludable**: open access resources **Non-rival and excludable**: recreational services **Non-rival and non-excludable**: public goods	Costanza 2008

The absence of unanimously accepted definitions of ES has been critically noted in the theoretical reviews (see for instance McCauley 2006; Schröter *et al.*, 2014) and real-world challenges (Sitas *et al.*, 2013; Beery *et al.*, 2016). Being criticized as too broad and highly theoretical, it is felt that reliable standards may facilitate the introduction of the ES approach in decision making (Seifert-Dähnn *et al.*, 2015; Schröter *et al.*, 2014). However, the author believes that achieving consensus on a strict definition may contradict the other prospect of ES as a multidisciplinary decision support tool. As noted in Chapter 2, similar criticism was directed at the concept of sustainable development, yet the concept was not abandoned. To the contrary, the broad definition has facilitated exploration (and quantification) of sustainability in different fields of study. The idea of "middle class" is used in everyday discourse as well as in the scientific literature and is useful in conveying an image of socio-economic structure but the definition of "middle class" has long been debated (Stearns, 1979; Eisenhauer, 2008; Lopez-Calva and Ortiz-Juarez, 2014) and it may be that in this case, a utility of the concept in application is its operational (or adaptive) definition.

More specifically, given all the definitions standardized and the practical guidelines established and broadly respected, they might eventually narrow down the application to the

original extent and silence any further development or explorations. The standardization can be exceptionally meaningful in specifically regulated contexts but not as such for others that are unconventional. The aborted opportunities are of particular importance given the potential of the concept has not yet been fully explored in the emerging applications such as urban green space design (Rall *et al*., 2015; Yang *et al*., 2015) or urban planning (Schmidt *et al*., 2014). Alternatively, flexible approaches could provide a piece of the definitions puzzle. Two components of such an approach are the adoption of modern freely interpretable terminologies and the combination of such with the field information, rigorously framed by clearly defined objectives. Gradually *joint products* crafted by practitioners' theories and stakeholders' empirical knowledge could constitute significant contributions. The success could be realized in site-specific definitions of ES using stakeholders' language, or the association of the concept of core terminologies with existing policies and regulations to highlight opportunities. This approach would essentially save the effort in trying to educate some stakeholders in the highly technical terminologies such as nature services, functions, *etc.* and attract interests of participation more effectively (Greenhalgh and Hart 2015; Verburg *et al*., 2016). In conclusion, we suggest that in addition to making an effort to standardize the concept, utilizing the ones at hand with flexible approach methodologies could offer numerous positive benefits.

5.2 The Issues of Scales

As a noun, Oxford Advanced Learner's Dictionary refers scales to a graduated range of values forming a standard system for measuring or grading. O'Neill & King (1998) link the definition to the physical dimension of phenomena (Hein *et al*., 2006). With these references, the term might be perceived to be solely related to the geographical matters such as landscape management. Accordingly, the search of "ES scales" in the scientific databases such as Scopus predominantly hits ES mapping practices (see, for instance, Naidoo *et al*., 2008; Plieninger *et al*., 2013) The issue of scale, as such, is associated with spatial and ecological dimensions. However, this matter substantially exceeds the colloquial mapping contexts (de Groot *et al*., 2002; Hein *et al*., 2006) and includes numerous relevant issues to decision making (de Groot *et al*., 2010)

Colloquially, ES scale reflects the provision of environment amenities with respect to space and time (Turner *et al*., 2000; Limburg *et al.*, 2002; Costanza. 2008; Geijzendorffer and Roche. 2013; Burkhard *et al.*, 2014). Some services are provided locally, and their benefits can be recognized immediately, such as fish catch and water supply from rivers, whereas the others' only become tangible at larger scales such as catchment scaled flood regulation or global scaled carbon sequestration. Ecosystems can also provide benefits at multiple scales, for instance, rivers can provide fish stock to local fishers and hydropower and navigation benefits to the whole country. In general, ES benefits can be generated at every spatial scale, but our understanding of scale interaction can be limited. It is, hence, crucial to recognize and clearly define the scales of particular analyses. Inappropriate choice of appropriate scale to analyze is prone to the omission of essential services or the inclusion of irrelevant ones that could result in unreliable outcomes such as over/underestimation, double counting, *etc.* (Turner *et al*., 2003).

Of equal importance, though seldom explicitly addressed, is the stakeholders' institutional scales. This scale distinguishes individuals and households at the smallest tier and national, continental or global at the largest. At each scale, the benefits are realized in different manners mostly determined by stakeholders' accessibility to the respective resources. For instance, fish stocks from the oceans at the same time provide benefits to individual fishermen, their villages, as well as international operating firms (Hein *et al*., 2006). The yields of these actors, however, are variable by their ability to harvest the fish schools. In principal, the utilization of ES can be observed at every institutional scale and so can conflicts between rival users. The conflicts emerge as soon as the natural stocks can no longer satisfy every users' demand. These potentially accrue to confrontation such as the Water War in Jordan River drainage basin between Israelis and their Arab neighbors (Lowi 1995). Efforts to avoid such circumstance must involve government agencies respected by all of the competing parties to fairly manage the utilization of resources. The requirements of both economic efficiency and social equity for such meditation tasks require deep understanding about the relevant institutional scales where rivalry has arisen. For instance, to resolve conflicts between households, judgment from local level meditators is more useful than by national government agencies, while inter-regional or multinational clashes require the interplay of largely entrusted international mediators such as the United Nations.

The third aspect of scale relates to the economic valuation of ES. The utilization of monetization results in decision making, however, is still limited due to the lack of scale-relevance in such studies (de Groot *et al*., 2010; Seppelt *et al*., 2011). ES evaluations based on the classification schemes of de Groot *et al*., (2002) or MA (2005) commonly assume the exclusiveness of different services, which colloquially rely on the value aggregation to calculate the total economic values of the overall ecosystems. For example, the total economic values of a particular forest could be estimated from aggregating values of individual ES such as timber, carbon sequestration, *etc*. These services are both important and valuable, but their ecological scales (biome vs. global) and institutional scales (local vs. global) are irrelevant making the aggregated results less relevant. These results are challenging to incorporate locally because the benefits of carbon sequestration to the local economy are difficult to tease out. Neither could it be useful globally because the global community has minute direct benefit from the local timber production. In general, results from such assumptions are prone to critical judgments with respect to both scientific robustness and decision-making relevance

In the previous paragraphs, we highlighted the individual significance of ecological scales of ES and institutional scales of associated stakeholders and finally, emerging issues of scale relevant ES evaluations. With respect to ecological scales, Hein *et al*., (2006) proposed the use of geographical dimensions to identify the appropriate ecological scales and to include respective regulation services. For example, for areas larger than 1,000,000 km^2, the study could be considered global, and as such, carbon sequestration and climate regulation should be included. Whereas for specific ecosystem consideration with 1-10,000 km^2 research area, ES considerations should include regulation of nutrients, pollution, pests and pathogens alongside protection from natural disasters. As with the definition of ES, however, these scales might be operationally defined and somewhat fluid where there is a necessity to scale up. For example, watersheds are of different sizes, for example, the Mekong River basin being 750,000 km^2, but they act as a connected upstream/downstream system (*e.g.*, dam construction in China may impact the downstream Tonle Sap Lake in Cambodia or the Mekong Delta in Vietnam). An individual water development project may have minimal impact on a large system, and so an EIA for a single project may reflect overall benefits, but environmental assessments have difficulty coming to

terms with the cumulative impact of multiple projects. Scaling up further, hypoxia (dead zones with low dissolved oxygen) in coastal areas around the world can result from high nutrient loadings and attendant eutrophication produced by changing land use (Rabalais *et al*., 2010). Hypoxia is a complex issue, but in some coastal areas, the nutrient inputs come from multiple large river systems.

Unfortunately, institutional scales of stakeholders are equally difficult. Suggestions of Geijzendorffer and Roche (2014) provided useful hints in choosing appropriate scales for analysis, for instance, provisioning service of water for non-drinking purposes is associated with *Large Institutions* stakeholders' scales at *Large Regional* spatial scales. However, robustness has not yet been reached due to the implicit and subjective discrimination between *Large* and *Small* Scales.

Given the complexity of institutional scales, different settings of institutional hierarchical systems and the cross-scales conflicts, it might be best to start from the ground, *i.e.*, by identifying who the beneficiaries are, at which scales their benefits are realized and challenged. Only by answering such elemental questions could the appropriate institutional scales be determined. Additionally, for those research/projects targeting the change of policies, it is also crucial to clarify the relationships among perceived benefits, associated ES, and deciding policies. The inter-relationships between these three actors are best evaluated through a well-structured conceptual framework such as proposed by Wainger and Mazzotta (2011) or Maynard *et al*., (2010). Perhaps this is an area in which the theory of waterscapes, as previously defined, also can help.

5.3 The Monetization Paradox

As economic valuation of ES has gained support from practitioners, it has as much been censured. Those who are advocates for ES favor the methods of the simplified comparison between conservation and development in terms of economic benefits, whereas those who oppose ES fall into two camps; those concerned that environment amenities should be appreciated for their existence, not for anthropogenic benefits and those who feel ES potentially wields too much influence on the decision-making process given the uncertainties in developing ES assessment. Presented herewith are some important benefits and criticisms on the use of

monetization, both of which are discussed within the context of supporting decision making and policy planning processes.

The economic valuation of ES is considered by many as what distinguished ES assessment from other environmental assessment approaches such as the 2001 Environmental Sustainability Index or the Ecological Deficit (Wackernagel and Rees. 1996; Wackernagel and Onisto. 1997). The ES interpretation of ecosystems' biophysical values in monetary terms has the potential to substantially back up conservationists' arguments which had been relying solely on moral calls such as the intrinsic values of biodiversity or the rarity of species, *etc.* (Beery *et al*., 2016). The integration of this anthropocentric factor alongside biophysical assessment could open dialogues between decision makers and scientists, among experts of different disciplines which used to be impossible. As such, potential outcomes from various decisions could be better communicated (Beery *et al.*, 2016) which could help resolve the classic rivalry between pro-developmentalists and conservationists (Steiner *et al.,* 2004; Baker *et al.,* 2013). In specific regard to decision making, Fisher (2009) concluded that the integration of economic concepts during the assessment of ES would make the results more immediately relevant. More specifically, such inclusion could substantially distinguish between services and benefits, highlighting the importance of marginal ecosystem changes and establishing safe minimum standards.

The numerous advantages and the mainstreaming of publications utilizing economic valuation methods had accrued to practitioners' general beliefs that (1) unless benefits can be monetized, they will be ignored (Wainger & Mazzotta 2011) and the (2) ES approach equates economic valuation, or a monetary value equals the total value of ES. (Ruckelshaus *et al.,* 2013; Beery *et al.,* 2016). Fundamentally, the ES approach has never been about putting price tags on environmental benefits (McCauley 2006; Turner *et al.,* 2008; Schröter *et al*., 2014). In fact, more than 80 percent of the ecosystem values could not be captured by economic valuations (Costanza *et al.,* 1997). Moreover, findings of Ruckelshaus *et al.* (2013) pointed out that decision makers and stakeholders prefer using a broad range of measurements, not only monetization. They at times object to the attachment of monetized values to existence values of rare species or spiritual values of sacred places. Another field study, interestingly yet ironically revealed that the more

stakeholders know about monetization of ES, the more skeptical they are regarding its validity (Beery *et al*., 2016). A lack of awareness of the difference between intrinsic and utilitarian values of ES could essentially allow for the belief that no such difference exist in the valuation of ES. Conversely, those who are better informed, and had some account of the value in mind, expressed their concerns that the valuation is not showing fair values that might accrue to the misguided applications of results. Likewise, in environmental assessment (EA) practices, the monetization is at the same time appreciated in opening doors to communicating about environmental matters to decision makers and questioned on methodological robustness (Baker *et al*., 2013).

To wrap up the discussions, a famous quote by Robert Nesta Marley [(2)] could be relevant: "Money cannot buy life." Accordingly, the monetization of ES is no silver-bullet and houses some potential risks. Within this section, the author does not target yet another review on either ESV in general or the classification of valuation methods. Such references can be made to Chapter 2 of this dissertation, and other publications, see for instance Turner et al. 2008, Christie et al. 2012, Liu *et al*. 2010, or Braat and de Groot 2012. This section seeks to shed useful lights in the misconception about the relationship between the ES and the economic valuation methods that can be used to evaluate them. The concept does not necessarily associate with the anthropogenic calculation of Nature values, and the overreliance of such could affect the profile of ES in decision making by attracting critiques from moral standpoints. Pragmatically, studying human benefits granted by Mother Nature through their intrinsic values is entirely consistent with the original concept of ES (Christie *et al*., 2012; Reyers *et al*., 2012).

5.4 The Emergence of Frameworks

In the ES related literature, there is a growing body of conceptual frameworks publications. One major advantage of using frameworks for ES research relates to their sequential and interrelated steps which make it easy to apply and identify knowledge gaps for further improvements (Baker *et al.*, 2013). However, their abundance in the literature body is criticized to have diversified the original objectives of ES and confused practitioners (Greenhalgh and Hart, 2015). One of the most comprehensive assessments of the ES framework was prepared by Nahlik *et al.,* (2012) who adopted the multi-criteria-analysis (MCA) method to evaluate eleven different

frameworks. The major contribution of this work is the generalized "characteristics of an operational framework" which are incorporated herewith:

(1) *A sound foundation of ES definitions and classifications*. The challenge to showcase this feature is that there are more than one classification schemes available. Choosing what to adopt is essentially a MCA problem involving the core research objective, data availability, disciplines, decision contexts, *etc.* Provided that all other criteria be fully met, the classification schemes suggested by MA (2005) would be best for pedagogical and communication purposes whereas valuation targeting frameworks fit better in human well-being based definitions and typologies of Wallace. (2007). See Fisher *et al.,* (2009)for more discussions regarding the definitions of core terms and typology schemes of ES.

(2) *Transdisciplinary approach.* The framework should include efforts from scientists of different backgrounds as well as non-scientist participants (Liu *et al.,* 2010; Sitas *et al.,* 2013; Cowling *et al*., 2008; Wainger and Mazzotta 2011). However, for a multidisciplinary team to collaborate effectively, each player has to "step out of their respective comfort zones". More specifically, ecologists would have to move away from asking their economists colleagues to put values to simple ecological metrics such as BOD, COD, salinity indices, *etc*. Likewise, unrealistically deterministic measures frequently raised by economists such as "how many fish kills can be avoided from one unit reduction of watershed impervious surfaces" should also be avoided (Wainger and Mazzotta, 2011).

(3) *Community engagement.* Stakeholders are the ultimate beneficiaries of ES-related research. Hence, to promote the outcomes of the frameworks beyond the boundaries of academic exercises, the involvement of interested parties to ensure the comprehensibility of terms and usability of the results once put into practice are both crucial. The first obstacle for teamwork is the language of participation. This issue is the most challenging in introducing ES into non-expert team members (Verburg *et al*., 2016), and as noted previously, particularly in the case of developing countries. Pedagogical efforts with off-the-shelf terminologies are more likely to fail with none expert stakeholders. Alternatively, a blank framework, only constrained by research objectives could invite stakeholders to participate actively and gradually develop the relevant definitions using their languages

and practical experiences. Some might criticize the uncertain "end points" of such an approach, but the implementation process that could generate public support may be considered a success itself (Waters *et al*., 2012). Also, the roles of stakeholders in sustaining the results in the aftermath are not substitutable given their social bonds to the homeland (Ruckelshaus *et al*., 2013; Cowling *et al*., 2008).

(4) *Resilient*. Given the ever changing conditions of natural and human factors, the frameworks should be sufficiently flexible and adaptive to account for the dynamic phenomena. In fact, the frameworks to include ES information should be developed as iterative and interactive science-policy processes (Ruckelshaus *et al*., 2013) so that new knowledge could be updated to favor effective, responsive measures. The resilience and adaptability of frameworks can be improved by the inclusion of a Champion agency or learning organization to receive and analyze information from all parties and propose corresponding measures (Cowling *et al*., 2008; Sitas *et al*., 2013).

(5) *Cohesive and coherent.* The underlying assumptions should be conceptually sound, and the framework structure should be logical and realistic. The interlinkages amongst steps strongly resonate with (1) the purpose of the model, (2) the definitions and classification scheme of the model, and (3) the envisioned "end products" of the frameworks.

(6) *Policy-relevant.* First, the information gained from a framework should be able to inform policy planners vis-à-vis possible outcomes of decision alternatives. Secondly, the metrics used in the measurements of ES could be controlled and influenced by policy (Wainger and Mazzotta 2011). This characteristic is relevant to highlight the important interplay of policy makers besides efforts from academia actors (Greenhalgh and Hart 2015; *Pittock et al*., 2012).

The author would, nevertheless suggest not taking all the criteria above as essential to developing operational frameworks, as there is no one-size-fits-all approach to environmental assessment. In principal, it might be acceptable that implementation characteristics *e.g.*, resilience, coherence or transdisciplinarity could be and, in fact, have been widely incorporated into many existing frameworks. However, trying to capture all these six *touchstones* within a particular project would be neither practical nor neccessary. Development of frameworks is driven by their

objectives (quantification, valuation, communication or mainstreaming) and success indicators (publications, community awareness raising, policy enhancements) which are largely different. Fundamentally, the framework's intended uses and expected outputs render the weights or concern levels of various characteristics as exemplified in Table 5.2. For instance, frameworks targeting public awareness should exhibit the *community engagement* characteristics the most explicitly which is not necessarily the case for valuation or mainstreaming frameworks. In addition, the diversity in developers' disciplines and other external conditions such as political conditions, stakeholders' attributes and more importantly, data availability, can have a substantial impact on the final configurations of frameworks.

Table 5.2 Characteristics of frameworks according to their objectives

Objectives	Success indicators	Relevant characteristics	References
Systemizing for understanding and education	Implicit awareness raised Implicit change of behavior	Sound definitions Cohesive and coherent Policy relevant	de Groot *et al.,* (2002) Kremen and Ostfeld (2015) Fisher et al. (2009) Rounsevell et al. (2010) Kremen & Ostfeld (2014)
Quantification and valuation	Estimated biophysical and/or economical values of ES Publications	Sound definitions Community engagement Cohesive and coherent	Hein *et al.,* (2006) Paetzold *et al.,* (2010) Wainger and Mazzotta (2011)
Community communication	Explicit change of stakeholders' behavior Publications	Community engagement Resilient Cohesive and coherent Policy relevant	Ruckelshaus *et al*., (2013) Daily *et al.,* (2009)
Mainstreaming in decision making	Improved policies	Policy relevant Transdisciplinary Resilient Cohesive and coherent	Turner and Daily (2008) Cowling *et al.,* (2008) Daily *et al.* (2009) Maynard *et al.,* (2010) Wainger & Mazzotta (2011)

5.5 Integration Opportunities

Full-scale integration of ES information within the planning process is not expected shortly due to the concurring barriers discussed in the previous sections (Mascarenhas *et al*., 2015). In addition to making efforts to overcome the inherent shortcomings of the concept such as the consolidation of core terminologies, exploring pathways that are primarily outside of the box is

of equal importance. One such implication is to include the ES information into existing decision support systems.

In this regard, the environmental assessment (EA) tools could make potential candidates considering the familiarity of such practices in the planning and regulatory sectors. The second justification for the integration lies in the scenario analysis approach that is currently adopted by both EA and ES frameworks. Thirdly, the current trend within EA practices to include socio-economic aspects to achieve sustainability is relevant to the ES approach which is well known for its ability to explicitly link environmental issues with human well-being. The existing barriers confronting the application of EA could be addressed, to some extent, with the inclusion of ES information in the methodological frameworks (Geneletti 2012). Table 5.3 synthesizes findings from Geneletti (2012) and Baker *et al*., (2013) representing (1) associated problems within EA frameworks, (2) criteria for an effective EA, and (3) potential contributions from ES in supporting each of these problems / criteria.

Table 5.3 Potential contributions of ES to EA frameworks

Problems within EA practices	Potential contributions of ES
Lack of effective scoping	ES could help shaping the assessment through the identification and prioritization of benefits (services).
Ineffective collection and use of baseline information in assessment	The ES information, through wider sources, is relevant in facilitating a more integrated approach.
Lack of alternatives consideration	The information of ES, especially economic valuation could ease the comparison. However, the inclusion of ES alone could not alleviate the barrier.
Limited understanding of cumulative effects and their significance	The integrated nature of ES concept is relevant to cumulative effects. Translating environment intrinsic values into stakeholders' benefits forms an effective way to assess the significance of effects.
Inadequate compliance with the mitigation hierarchy	The analysis of trade-offs and synergies of ES is relevant in this respect. However, this is still limited in ES literature.
Lack of effective community consultation and engagement	An ES approach offers more public-friendly platforms for communication using "benefits" and "uses" terms. In fact, stakeholders' engagement is one of the operational characteristics of ES frameworks (4.1)
Being seen as a hurdle	Practitioners can benefit from ES information in some ways, but the inclusion might be criticized for adding a burden. How the process performed and benefits demonstrated remain essential for judgment.

Criteria of an Effective EA	
Integrated	ES could address the relationship between biophysical and socio-economic aspects explicitly. The scale-referenced of ES is relevant to the variable nature of decision-making levels.
Sustainability-led	ES effectively links changes in the environment with effects on human well being using benefits and uses. This is relevant to the sustainability target of EA practices.
Focused	ES approach could highlight key issues for the specific decision contexts vis-à-vis human-environment interactions.
Participatory	The identification of beneficiaries and stakeholders could facilitate a participatory approach for EA.
Accountable	Analysis of future scenarios in ES could reflect how sustainability is considered to justify planning alternatives.
Iterative	ES information can be included in different forms, at various stages of the process to inform the expected impacts of options through different "decision windows."

The inherent difficulties in coupling ES and EA include the conceptual complexity, the robustness of economic and non-economic valuations, trade-offs and synergies of services according to legal frameworks in specific contexts, and the resource intensiveness of the assessment process. (Baker *et al*., 2013; Rega and Spaziante 2013; Karjalainen *et al*., 2013). Also, methodological challenges are consisting of the identification of which ES to include; the selection of conceptual definitions, trade-offs, and synergies between ES; the appropriateness of indicators and the issues of scales (Geneletti 2012; Karjalainen *et al*., 2013)

So far, the experiences in integrating ES information with EA include methodological frameworks and analysis (Honrado *et al*., 2013; Helming *et al*., 2013; Partidario and Gomes 2013; Karjalainen *et al*., 2013; Geneletti 2012); web-based application (Broekx *et al*., 2013); synthesis reports on case-studies (Baker *et al*., 2013; Honrado *et al*., 2013; Rega and Spaziante 2013; Geneletti 2013) and methodological reviews (Geneletti 2012). Readers of particular interest in this topic can refer to UNEP (United National Environment Programme) (2014), a comprehensive cookbook in using ES knowledge for EA practices. All the literature previously cited originated from European countries, signifying the major knowledge gap regarding the approach applicability in different contexts, particularly in the developing world. In other words, experimenting with this method in different socio-economic and political conditions could substantially refine the methodology, paving the way to a larger utility.

5.6 The Interplay of Policy Actors

Throughout this manuscript, within several contexts, we have highlighted the relevance of the political dimension of the ES approach. To underscore this issue, we incorporate herewith examples from two countries: the United States and Vietnam, which have contrasting development contexts.

Among the developed world, examples from the United States of America (USA) constitute several important implications. In particular, the U.S. President Obama issued an Executive Order in 2009 calling related departments to safeguard the health of the environment, which led to the implementation of more than 200 programs and projects from Federal Agencies (Cox et al. 2013). Among these initiatives the Ecological Benefits Assessment Plan of the US Environment Protection Agency (USEPA), Markets for Ecosystem Services by the US Department of Agriculture (USDA), and the establishment of the National Ecosystem Services Team (NESST) by the US Forest Service (USFS) were notable (Hirokawa 2011, Schafer *et al.*, 2015). In October 2015, the USA made another large step forward with a White House Directive (hereinafter the Directive) entitled "Incorporating ES into Federal Decision Making" from the Office of Management and Budget (OMB), the Office of Science and Technology Policy (OSTP) and the Council of Environmental Quality (CEQ). Through the Directive, the Government has been able to mandate Federal Agencies to (1) develop and institutionalize policies to promote consideration of ES in planning, investments and regulations and (2) implement policies to integrate ES assessments at the appropriate scales, into relevant programs by their statutory authority. Initiatives from the Federal Agencies are supported by CEQ and OMB, in collaboration with subject-matter experts, and will be subjected to several reviews, *i.e.*, external peer-reviews, public comments, and interagency review processes. The Directive also regulates the OMB, OSTP, and CEQ to play the leading roles in facilitating interagency coordinations including supporting agencies to successfully integrate ES in their decision making, cooperating with external work groups, and developing long-term strategies. As noted previously, it seems unlikely that the new Executive in the U.S. will continue on the course of this progressive action.

The second example is associated with the political appraisal performed in Chapter 4 (Loc *et al*., 2016). To recall, Chapter 4 presents how the outcomes from a typical ES valuation study could be utilized to improve the current agricultural land pricing system. By reviewing the relevant legal documents, the author underscores the limitations of the current land pricing system, hence highlight opportunities to integrate ES knowledge to reform the relevant regulations. More specifically, the current land pricing system in the research area does not consider the major differences among diverse annual crops regarding their profitability, including both extensive farming (rice, vegetables) and rotational crops (PRRC). The registration for each type of crop within the national land use planning can be time-consuming and costly given the complexity of the associated legal framework. Therefore, an ES-based index to account for the differences among the crops was proposed. The recommendation, as such, is substantially facilitated by the Ministry of Environment and Natural Resources Decree, which allows for the application of correction factors according to local conditions. The approach provides a solid foundation on how to transform the results from ES valuation studies into policy improvements via the analysis of associated legal documents.

5.7 Summary and Conclusions

In this chapter, three important methodological mismatches were addressed regarding (1) the diversity of terminologies, (2) the issue of scales, and (3) monetization; alongside three approaches were highlighted, namely (4) the conceptual frameworks, (5) the integration of ES in other decision support tools, and (6) the interplay of policy players. In the first section, the author argued that the lack of consensus could, in fact, reveal opportunities to explore innovative usages of the concept in a wide range of scientific disciplines. Subsequently, the importance of stakeholders' institutional scales was discussed, highlighting the relevance of scale-relevant studies, cross-scale issues and proposed guiding questions for practitioners to consider in this regard. Regarding the economic valuation of services, the author shares the view with Christie *et al*., (2012), Reyers *et al*., (2012), and Schröter *et al*., (2014) objecting to the overreliance on monetization methods given its associated risks in decision making (Ruckelshaus *et al*., 2013; Beery *et al*., 2016). Summarized in section 5.4 are six characteristics (criteria) of an operational ES

framework. The author argues that purpose wise, satisfying all these criteria with a single framework would be impractical and unnecessary. The author accordingly suggests the most relevant criteria for different purposed ES frameworks. Significant opportunities in coupling ES with EA was elaborated through Section 5.5 with suggested future research directions into this combination within developing countries' contexts. Finally, yet importantly, the author exemplified the relevance of policy players through the achievements of USA with respect to the integration of ES in decision-making processes.

It could be inferred from these discussions that best practices in applying ES concepts in decision-making have yet to be consolidated. This absence implies that the mainstreaming of ES remains more an exploration than a validated framework. Methodological critiques, analysis, and case study explorations remain the norm yet their findings have begun to converge such as revealed in the review process. On the optimist side, this could help to identify relevant limitations under multiple perspectives and improve the methodology. Within the scope of this chapter, the author did not have the opportunity to address other important aspects such as trade-offs and synergies between ES; market incentives for ES such as Payment for ES (PES); and the emergence of ES assessment databases due to the lack of resources. The presented information, nonetheless, has introduced the systematic categorization of current ES knowledge with regard to popular prospects, concurring caveats, through which ways forward could be shaped. This review of the current profile of the knowledgebase could help structuring relevant research needs to complement the current knowledge gaps and to realize ES as the key driver for environmental policies.

Notes

(1) *Chimera* is originally known as a monster from Greek myths. The term usually refers to something that does not exist in reality (Oxford Learner's Dictionary).

(2) Robert Nesta "Bob" Marley (6 February 1945 – 11 May 1981) was a Jamaica singer, songwriter, musician, and guitarist who had achieved international fame *e.g.* Rock and Roll Hall of Fame (1994); Grammy Lifetime Achievement Award (2001); UK Music Hall of Fame (2004), *etc.*

References

Baker, J., Sheate, W.R., Phillips, P. and Eales, R., 2013. Ecosystem services in environmental assessment - Help or hindrance? *Environmental Impact Assessment Review*, 40(1), pp. 3–13.

Beery, T., Stålhammar, S., Jönsson, K.I., Wamsler, C., Bramryd, T., Brink, E., Ekelund, N., Johansson, M., Palo, T. and Schubert, P., 2016. Perceptions of the ecosystem services concept: Opportunities and challenges in the Swedish municipal context. *Ecosystem Services*. 17, pp. 123–130.

Boyd, J. and Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, 63(2-3), pp. 616–626.

Braat, L.C. and de Groot, R., 2012. The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosystem Services*, 1(1), pp. 4–15.

Broekx, S., Liekens, I., Peelaerts, W., De Nocker, L., Landuyt, D., Staes, J., Meire, P., Schaafsma, M., Van Reeth, W., Van den Kerckhove, O. and Cerulus, T., 2013. A web application to support the quantification and valuation of ecosystem services. *Environmental Impact Assessment Review*, 40, pp. 65–74.

Burkhard, B., Kandziora, M., Hou, Y. and Müller, F., 2014. Ecosystem service potentials, flows and demands-concepts for spatial localisation, indication and quantification. *Landscape Online*, 34(1), pp. 1–32.

Chan, K.M.A., Shaw, M.R., Cameron, D.R., Underwood, E.C. and Daily, G.C., 2006. Conservation planning for ecosystem services. PLoS Biology, 4(11), pp. 2138–2152.

Christie, M., Fazey, I., Cooper, R., Hyde, R. and Kenter, J.O., 2012. An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. *Ecological Economics*, 83, pp.67–78.

Costanza, R., Arge, R., Groot, R. De, Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V, Paruelo, J., Raskin, R.G., Suttonkk, P. and van den Belt, M., 1997. The value of the world ' s ecosystem services and natural capital. *Nature*, 387(May), pp. 253–260.

Costanza, R., 2008. Letter to the Editor Ecosystem services : Multiple classification systems are needed. *Biological Conservation*, 141(2008), pp. 350–352.

Cowling, R.M., Egoh, B., Knight, A.T., O'Farrell, P.J., Reyers, B., Rouget, M., Roux, D.J., Welz, A., Wilhelm-Rechman, A., 2008. An operational model for mainstreaming ecosystem services for implementation. *Proceedings of the National Academy of Sciences U.S.A* , 105(28), pp. 9483–9488.

Cox, L.M., Almeter, A.L. and Saterson, K.A., 2013. Protecting our life support systems: An inventory of U.S. federal research on ecosystem services. *Ecosystem Services*, 5, pp.163–169

Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: Time to deliver. *Frontiers in Ecology and the Environment*, 7(1), pp.21–28.

de Groot, R.S. , Alkemade, R., Braat, L., Hein, L. and Willemen, L., 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity*, 7(3), pp. 260–272.

de Groot, R.S., Wilson, M.A. and Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, 41(3), pp. 393–408.

Eisenhauer, J.G. 2008. An economic definition of the middle class. *Forum for Social Economics*. 37(2), pp. 103-113.

Executive Office of the President, 2015. Memorandum for Executive Departments and Agencies: Incorportating Ecosystem Services into Federal Decision Making. Executive Office of the President, Washington, DC

Fisher, B., Turner, R.K. and Morling, P., 2009. Defining and classifying ecosystem services for decision making. *Ecological Economics*, 68(3), pp. 643–653.

Geijzendorffer, I.R. and Roche, P.K., 2014. The relevant scales of ecosystem services demand. *Ecosystem Services*, 10, pp. 49–51.

Geneletti, D., 2012. Reasons and options for integrating ecosystem services in strategic environmental assessment of

spatial planning. *International Journal of Biodiversity Science, Ecosystem Services and Management*, 7(3), pp. 143–149.

Geneletti, D., 2013a. Assessing the impact of alternative land-use zoning policies on future ecosystem services. *Environmental Impact Assessment Review*, 40(1), pp.25–35.

Geneletti, D., 2013b. Ecosystem services in environmental impact assessment and strategic environmental assessment. *Environmental Impact Assessment Review*, 40, pp. 1–2.

Greenhalgh, S. and Hart, G., 2015. Mainstreaming ecosystem services into policy and decision-making: lessons from New Zealand's journey. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 3732(June), pp. 1–11.

Hein, L., van Koppen, K., de Groot, R.S. and van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological Economics*, 57(2), pp. 209–228.

Helming, K., Diehl, K., Geneletti, D. and Wiggering, H., 2013. Mainstreaming ecosystem services in European policy impact assessment. *Environmental Impact Assessment Review*, 40(1), pp. 82–87.

Hirokawa, Keith H. 2011. Sustaining Ecosystem Services Through Local Environmental Law, 28 *Pace Environmetal Law Review*. 760

Honrado, J.P., Vieira, C., Soares, C., Monteiro, M.B., Marcos, B., Pereira, H.M. and Partidário, M.R., 2013. Can we infer about ecosystem services from EIA and SEA practice? A framework for analysis and examples from Portugal. *Environmental Impact Assessment Review*, 40, pp. 14–24.

Karjalainen, T.P., Marttunen, M., Sarkki, S. and Rytkönen, A.M., 2013. Integrating ecosystem services into environmental impact assessment: An analytic-deliberative approach. *Environmental Impact Assessment Review*, 40, pp. 54–64.

Kremen, C. and Ostfeld, R.S., 2015. Call To Ecologists : Measuring , Analyzing , Managing Ecosystem. , 3(10), pp. 540–548.

Limburg, K.E., O'Neill, R.V., Costanza, R. and Farber, S., 2002. Complex systems and valuation. *Ecological Economics*, 41(3), pp. 409–420.

Liu, S., Costanza, R., Farber, S. and Troy, A., 2010. Valuing ecosystem services. Theory, practice and the need for a transdisciplinary synthesis. *Ecological Economics Reviews.* Book Series: Annals of the New York Academy of Sciences. 1185, *pp.* 54 – 78.

Loc, H.H., Irvine, K.N., Thi Hong Diep, N., Thi Kim Quyen, N., Tue, N.N. and Shimizu, Y., 2016 (In Press). The legal aspects of Ecosystem Services in agricultural land pricing, some implications from a case study in Vietnam's Mekong Delta. *Ecosystem Services*.

Lopez-Calva, L.F., and Eduardo Ortiz-Juarez, E. 2014. A vulnerability approach to the definition of the middle class. *The Journal of Economic Inequality* 12(1), pp. 23-47.

Lowi, Miriam R. 1995. Water and power: the politics of a scarce resource in the Jordan River Basin. Cambridge University Press. ISBN 978-0-521-55836-5.

MA (Millennium Ecosystem Assessment), 2005. Ecosystems and human well-being: Synthesis. Island Pres, Washington D.C. World Press Institute.

Mann, C., Loft, L. and Hansjürgens, B., 2015. Governance of Ecosystem Services: Lessons learned for sustainable institutions. *Ecosystem Services*, 16, pp. 275–281.

Mascarenhas, A., Ramos, T.B., Haase, D. and Santos, R., 2015. Ecosystem services in spatial planning and strategic environmental assessment-A European and Portuguese profile. *Land Use Policy*, 48, pp. 158–169.

Maynard, S., James, D. and Davidson, A., 2010. The development of an ecosystem services framework for South East Queensland. *Environmental Management*, 45(5), pp. 881–895.

McCauley, D.J., 2006. Selling out on nature. *Nature*, 443(7107), pp. 27–28.

Nahlik, A.M., Kentula, M.E., Fennessy, M.S. and Landers, D.H., 2012. Where is the consensus? A proposed foundation for moving ecosystem service concepts into practice. *Ecological Economics*, 77, pp. 27–35.

Naidoo, R., Balmford, a, Costanza, R., Fisher, B., Green, R.E., Lehner, B., Malcolm, T.R. and Ricketts, T.H., 2008. Global mapping of ecosystem services and conservation priorities. *Proceedings of the National Academy of Sciences.* 105(28),

pp. 9495–9500.

O'Neill, R.V. and King, A.W., 1998. Hommage to St Michael: or why are there so many books on scale? In: Peterson, D.L., Parker, V.T. (Eds), Ecological Scale: Theory and Applications. Columbia University Press, New York, pp. 3-15.

Partidario, M.R. and Gomes, R.C., 2013. Ecosystem services inclusive strategic environmental assessment. *Environmental Impact Assessment Review*, 40(1), pp. 36–46.

Pittock, J., Cork, S. and Maynard, S., 2012. The state of the application of ecosystems services in Australia. *Ecosystem Services*, 1(1), pp. 111–120.

Plieninger, T., Dijks, S., Oteros-Rozas, E. and Bieling, C., 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy*, 33, pp. 118–129.

Rabalais, N.N., Diaz, R.J., Levin, L.A., Turner, R.E., Gilbert, D., and Zhang, J. Dynamics and distribution of natural and human-caused hypoxia. *Biogeosciences*, 7, pp. 585-619.

Rall, E.L., Kabisch, N. and Hansen, R., 2015. A comparative exploration of uptake and potential application of ecosystem services in urban planning. *Ecosystem Services*, 16, pp. 230–242.

Rega, C. amd Spaziante, A., 2013. Linking ecosystem services to agri-environmental schemes through SEA: A case study from Northern Italy. *Environmental Impact Assessment Review*, 40, pp. 47–53.

Reyers, B., Polasky, S., Tallis, H., Mooney, H.A. and Larigauderie, A., 2012. Finding Common Ground for Biodiversity and Ecosystem Services. *Bioscience*, 62(5), pp. 503–507.

Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Ricketts, T., Bhagabati, N., Wood, S.A. and Bernhardt, J., 2013. Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. *Ecological Economics*, 115, pp. 11–21.

Schmidt, J.P., Moore, R. and Alber, M., 2014. Integrating ecosystem services and local government finances into land use planning: A case study from coastal Georgia. *Landscape and Urban Planning*, 122, pp. 56–67.

Schröter, B. Matzdorf, B., Sattler, C. and Alarcon, G.C., 2015. Intermediaries to foster the implementation of innovative land management practice for ecosystem service provision - A new role for researchers. *Ecosystem Services*, 16, pp. 192–200.

Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S. and Opdam, P., 2014. Ecosystem Services as a Contested Concept: A Synthesis of Critique and Counter-Arguments. *Conservation Letters*, 7(6), pp. 514–523.

Seifert-Dähnn, I., Barkved, L.J. and Interwies, E., 2015. Implementation of the ecosystem service concept in water management – Challenges and ways forward. *Sustainability of Water Quality and Ecology*, 5, pp.3–8.

Seppelt, R., Dormann, C.F., Eppink, F. V., Lautenbach, S. and Schmidt, S., 2011. A quantitative review of ecosystem service studies: Approaches, shortcomings and the road ahead. *Journal of Applied Ecology*, 48(3), pp. 630–636.

Sitas, N., Prozesky, H.E., Esler, K.J. and Reyers, B., 2013. Opportunities and challenges for mainstreaming ecosystem services in development planning: perspectives from a landscape level. *Landscape Ecology*, pp. 1–17.

Stearns, P.N. 1979. The Middle Class: toward a precise definition. Comparative Studies in Society and History 21(3), pp. 377-396.

Steiner, A., McCormick, S.J. and Johnson, I., 2004. *How much is an Ecosystem Worth?Assessing the economic value of conservation*, The International Bank for Reconstruction and Development/THE WORLD BANK.

TEEB foundations, 2010. The economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London and Washington D.C.

Turner, R.K. and Daily, G.C., 2008. The ecosystem services framework and natural capital conservation. *Environmental and Resource Economics*, 39(1), pp. 25–35.

Turner, R.K., Van den Bergh, J.C.J.M., Soderqvist, T., Barendregt, A., Van der Straaten, J., Maltby, E. and Van Ierland, E.C., 2000. Ecological-economic analysis of wetlands: Scientific integration for management and policy. *Ecological Economics*, 35(1), pp. 7–23.

Turner, R.K, Paavola, J., Cooper, P., Farber, S., Jessamy, V. and Georgiou, S., 2003. Valuing nature: Lessons learned and future research directions. *Ecological Economics*, 46(3), pp. 493–510.

Turner, R.K., Georgiou, S. and Fisher, B., 2008. *Valuing Ecosystem Services: The Case of Multi-Functional Wetlands*,

UNEP (United National Enviornment Programme), 2014. Integrating Ecosystem Services in Strategic Environmental Assessment: A guide for practitioners. A report of Proecoserv. Geneletti, D. , p.66.

Verburg, R., Selnes, T. and Verweij, P., 2016. Governing ecosystem services: National and local lessons from policy appraisal and implementation. *Ecosystem Services*, 18, pp. 186–197.

Wackernagel, M., Onisto, L., et al., 1997. Ecological Footprints of Nations: How much Nature do they use? How much Nature do they have? The Earth Council, San Jose,Costa Rica.

Wackernagel, M., Rees, W., 1996. Our Ecological Impact: Reducing Human Impact on the Earth. The Society Publishers, Forum.British Colombia.

Wainger, L. and Mazzotta, M., 2011. Realizing the potential of ecosystem services: A framework for relating ecological changes to economic benefits. *Environmental Management*, 48(4), pp. 710–733.

Wallace, K.J., 2007. Classification of ecosystem services: Problems and solutions. *Biological Conservation*, 139(3-4), pp. 235–246.

Waters, R., Lusardi, J. and Clarke, S., 2012. Delivering the ecosystem approach on the ground – an evaluation of the upland ecosystem service pilots. Natural England Research Reports, number 046. , p.58.

White, L., Jr, 1967. The historical roots of our ecological crisis', *Science* 155, pp. 1203-1207.

Yang, L., Zhang, L., Li, Y., Wu, S., 2015. Water-related ecosystem services provided by urban green space: A case study in Yixing city (China). *Landscape and Urban Planning*, 136, pp. 40–51

Chapter 6

Conclusions and Recommendations

6.1 Conclusions

Human benefits derived from nature are manifold, and this had been acknowledged and documented well before ES. This fundamental reliance of human, until the second half of the last century, has been associated with solely moral standpoints through intrinsic values, making the measurements implicit, thus rarely considered in decision making. Therefore, the utilitarian approach introduced by the modern ES method has the potential to constitute the turning point in the conservationists' favor by reinforcing their rivalry arguments against pro-developers. Plus, environment assessment exercises performed through the exploration of anthropogenic benefits could be communicated more conveniently to decision makers than approaches exclusively based on the biophysical evaluation. The concept, however, is no silver bullet and has revealed various shortcomings, emerging from its theoretical base, *e.g.*, the lack of consensus in core terminologies, and practical applications, the fundamental similarity with the existing environmental regulations. The applicability of ES in a developing country context, such as Vietnam, is further challenged by various methodological and practical factors, *e.g.*, the lack of research capacity, literacy barriers, limited awareness and commitment from public sectors, *etc.*

In principle, these pros and cons of ES nowadays greatly resemble "sustainable development" formalized some thirty years ago. Therefore, it would be difficult to expect the integration of ES in the mainstream environment policies or legal legislations in the coming years. Against all the odds, relentless efforts from the scientist community have led to a number encouraging outputs. Notable achievements include, for example, the publication of the dedicated peer-reviewed journals, *e.g.*, *Ecosystem Services*, *One Ecosystem*, *etc.* and the introduction of ESP (Ecosystem Services Partnerships *http://es-partnership.org*) to promote international research collaboration among universities, institutes, and individual scholars.

As a contribution to the enhance ES valuation methodology and to address the limitations of case studies associated with less developed country context, the targets of this research include (i) the identification, evaluation and mapping of significant ES within the research area; (ii) the improvements in the existing policies from the research outcomes; and (iii) the contributions to the relevant research methods. These targets are collectively realized through concrete results from case studies, policy appraisals, and critical literature review documented through the contents of this dissertation.

Chapter 2 not only serves as a regular review of the state-of-the-art knowledge but a consolidation of research methodology as well. In addition to a summary of ES modern history, available methods for quantifying, evaluating and mapping different kinds of services are introduced. Within the literature reviewed, the most commonly cited benefits of ES include its ability in connecting society and nature, supporting decision making in diverse disciplines, and constituting an integrated approach in environment assessment. However, the concept has also been criticized in some manners, both through theoretical critiques and practical observations, for instance, the exclusion of the intrinsic value of nature, the economic metaphor of human-nature relationships, etc. Collectively, these challenges have hindered the application of ES in decision-making practices.

In Chapter 3, significant technical findings and logical inferences collected from three individual case studies are reported. In particular, Case study 1 sought to quantify, evaluate and map ES associated with the Prawn Rice Rotational Crop (PRRC) ecosystem in An Minh District. This rotational system was adopted as a counter-measure to the periodical salinity intrusion of the area, which heavily affects the productivity of rice crops. The services evaluated comprise of all the provisioning, regulating and supporting services, collectively constituting the favorable conditions for cultivation activities. Each of these, however, is absent from any real markets, hence challenging to quantify and valuate in economic terms. Therefore, the valuation of the associated ES was done through the market values of their mutual end-products, the crops, after subtracting the anthropogenic inputs being all the costs related to the farming practices, *e.g*. seeds, fertilizers, labor force, *etc*. The results confirm the suitability of PRRC in coping with the adverse

natural conditions while revealing the diverse adaptability of the residents to the rotational cultivation system. The study also explores the limitations of the existing policy in land-use classification and pricing. More specifically, the legal documents do not treat rotational crop as an individual land-use with respective prices, henceforth, overlooks the potential productivity of the land resources. As a contribution to the ES research methods, this case study contributed an integrated assessment framework to explore the economic values of ES associated with agricultural systems.

The second case study developed and applied a comparative method to measure landscape cultural quality via the assessment and mapping of relevant cultural Ecosystem Services (CES). Three indicators, two survey-based (Richness and Quality of ES), and one GIS-based (Willingness to Travel (WTT)) were proposed to evaluate seven popular tourism sites of Ha Tien Town, located in the North West of Kien Giang province. Primary data collection was done through face-to-face interviews with structural questionnaires at 123 residents' households of Ha Tien. In general, results from CES Richness measurement largely correlate with the popularity status of the landscapes. For instance, the most popular tourism site of the area, Mui Nai has the highest Richness figures, both services, and disservices. CES Quality, via Principal Component Analysis, points to the diverged perceptions among the communities concerning the associated CES, in particular between *Ritual Interactions* and other recreational related services. Of equal note are the detected synergies and trade-offs among the evaluated CES via Spearman Spatial Correlation and Correspondence Analysis. These findings could inform policy planners of the attractiveness as well as emerging issues associated with each landscape via social judgments, paving the way to the enhancement of local tourism development. Largely different from CES Richness and Quality, the last indicator WTT relies on the spatial analyst to produce an objective metric for landscape quality assessment. Using Network Analyst tool of ArcMap software, the shortest drivable routes connecting each respondent' household and each evaluated landscape were calculated, then combined with the respective traveling frequencies also collected through the interviews. In general, WTT results are also in line with the two measurements above in benchmarking the landscape quality. However, two most distant sites with considerably fewer CES were ranked comparative higher in WTT. This finding suggests that there might be some other *hidden appeal* in traveling to those places that the list of CES framed within this study failed to accommodate, *e.g.* communal ties, childhood experience. Nevertheless, with the powerful spatial analyst capacity of GIS, WTT could have offered a reliable and equitable method to evaluate landscape quality besides the popular yet controversial money-based indices, e.g. Willingness to Pay or Willingness to Accept. In a nutshell, findings

from the second case study expanded on the understanding of structural links between landscape geophysical attributes derived CES and the benefits of human well-being.

The last case study within the trilogy utilized Public Participatory GIS approach in locating, quantifying and mapping a full list of ES associated with U Minh Thuong National Park (UMTNP), located in the Southern region of Kien Giang. More specifically, the list of evaluated ES includes 5 Provisioning Services (Water, Fishing, Timber, Non-timber forest products, and grass for grazing); 4 Supporting Services (Soil Conservation, Nutrients Cycling, Air Purification, and Habitat); and Cultural Services (Recreation and Tourism). Alongside, 3 Dis-services, including Fire, Disease, Animal Attacks were also evaluated. The mapping of these (dis-)services was done across four types of Land Covers, i.e. Forests, Grassland, Swamps and Open Water Bodies. In general, Dis-services were recognized to a far lesser extent than services with Disease and Fire being the most relevant concerns. Supporting Services are the most identified, followed by Provisioning and Cultural. Individual service with the most recognition is Habitat, which implies the residents' acknowledgment of this important function of UMTNP. All four category of services and disservices are associated with every land cover, however, with largely diverged patterns. For instance, Provisioning accounts for the most Services related to Water Bodies, whereas, Supporting are predominant for all other land covers. Cultural and Dis-services, on the other hand, are exclusively related to Forests. Concerning the diverged preferences towards the evaluated services, Principal Component Analysis followed by Hierarchical Cluster Analysis were used to develop the higher order of representation for the data collected. In general, three largely different groups of preferences were identified. While some demonstrated high regards for the multiple benefits derived from the biosphere reserve, others are not as likely, which potentially leads to conflicts over the utilization and reservation of the shared resources. The depreciating attitudes of some specific individuals, on the other hand, are of particular relevance to illegal animal trapping, water polluting, fires, etc. that have been underscored as standing threats to UMTNP. Another noteworthy finding from these analyses is the relatively underrated Cultural Services compared to the substantial annual revenue from eco-tours. This mismatch implies the need for public awareness improvement. In addition to enforcement or education efforts, it might be as important to involve local inhabitants into the operation of the associated eco-tours, which could gradually nurture the protective behaviors within the community.

Chapter 4 explores how the outcomes from a typical ES valuation study could be utilized to support policy planners or decision makers, through an example of a suggested policy reform for the agricultural land pricing system in Vietnam's Mekong Delta. Driven by the limitations of the effective land pricing system of An Minh district revealed in the first case study, a thorough review of relevant legal documents was performed, in which, opportunities to apply ES knowledge for improvements were highlighted. More specifically, by referring to the National Decrees that allows for the use of correction factors in land pricing, an ES-based index was suggested to account for the differences in land profitability. The political appraisals performed also included three important national legislations related to the environment protection strategy and sustainable economic development goals. Within these documents, ES related keywords and concepts, such as Payment for Ecosystem Services, Ecosystem Services Structure, Natural Capital, etc. have been used, signifying in the recognition and support of the national government for ES approach in the mainstream decision-making agendas. Also, the approach developed herewith has contributed significant implications on how to mainstream scientific research outcomes into policy planning and decision-making processes, one of the most critical barriers to advancing ES knowledge.

Chapter 5 discusses how to move forward with the ES methodology, analyzing, and inferring via relevant literature and the case studies. In particular, three mismatches, namely the diversity of terminologies, the issue of scales, and the monetization paradox could be the most relevant to the application of ES. About the first mismatch, although frequently criticized as posing barriers to the practical application, the lack of consensus on ES method could reveal opportunities to explore innovative usages in different scientific disciplines, and thus should not be treated as a real barrier. Subsequently, the issues of scales which are associated with both the biophysical scales of ES and the institutional scales of beneficiaries are discussed. In practice, benefits are identified, quantified (preferably in money terms) and aggregated across the research area, regardless of their biophysical scales. For instance, aggregation of Timber production (at the local scale) with Flood Protection (at landscape scale), or even CO2 sequestration (at a global scale) does not constitute any valid information to decision making as the results are double-counted and essentially over-estimated. About the stakeholders' institutional scale, the problems are associated with the emerging conflicts between users over the shared resources. These two have highlighted the requirement for future ES studies to consider scale factors in their problem framing explicitly. Regarding the economic valuation of services, the advantages of monetization were underscored. However, the overreliance on these methods is prone to several risks in decision making, especially in

evaluating non-marketed benefits such cultural, spiritual services. In addition to these methodological mismatches, Chapter 5 also takes note of the emergence of analytical frameworks, the combination of ES and other decision-making tools, and the roles of policy actors. In the first section, six characteristics (criteria) of an operational ES framework are summarized. However, it is questionable that purpose wise, satisfying all these criteria with a single model would be impractical and unnecessary. The following section summarizes several prospects in coupling ES knowledge with Environmental Impact Assessment and highlights the current gaps associated the developing country contexts. Finally, to represent the crucial roles of policy actors in ES methodology, two examples with largely contrastive contexts are used. The first one relates to the achievements of the U.S.A. through the 2015 White House Directive which involves the White House Offices and several Federal Agencies in developing, peer-reviewing and applying ES-integrated federal policies and regulations for environmental protection. The second example is the summary of the main findings from Chapter 4 of this Dissertation, discussing the opportunities to combine research outcomes from an ES evaluation study to improve the existing land pricing policies.

6.2 Recommendations

Discussions within Chapter 5 of this dissertation present relevant research needs in the future via highlighting some critical methodological barriers associated with the application of ES approach. Plus, via the practical observations collectively acquired through the case studies, the following suggestions are of equal importance.

Considering the economic valuation of material inputs, future studies adopting the integrated market method as proposed in this research to evaluate the economic values of ES associated with other cultivation systems are recommended. At the same time, the evaluating formula should be expanded so that it can accommodate the adverse effects from cultivation activities that the ecosystems must bear. As such, Eq.1 can be rewritten as follows:

$$ESV = TR - (FC + VC + OC) \mp EDS \qquad \text{(Eq. 3).}$$

Where ESV = ES Values, TR = total revenue from crops, FC = Fixed costs, VC = Variable costs, OC = Opportunity Costs and EDS = Ecosystem Disservices.

These *negative* ES include water pollution, soil degradation or the deterioration of ecosystems through the use of fertilizers, agrochemicals or PEST control chemicals. The values of these dis-

services can be calculated through avoided costs, e.g. man-made treatment facilities. This inclusion would essentially complement the economic evaluation of ES associated with agricultural ecosystems.

Of equal note is the need of multi-temporal measurements to both look back in the history and envision the changes in the future to account for potential variations and consolidate the estimations of ES values. Once accomplished, these studies would be able to enhance the snapshot findings of the presented case study into a more holistic assessment of both the economic productivity but also the health of the ecosystems. In the future, as more data become available and long-term measurements become possible, the use of numerical models or advanced data analysis techniques, such as machine learning algorithms would be come more relevant in supporting ES research.

On the assessment of non-utilitarian ES associated with cultural landscapes that also offer tourism benefits, future studies are encouraged to incorporate the perspectives of not only the local residences but also visitors, especially foreigners. Comparative assessments of anticipations between these two groups of beneficiaries are of particular importance to enhancing the values of tourism products without compromising the ecological balance and the cultural identity of the landscapes. Concerning the methods, the presented case study has placed a significant ground for the use of spatial data, *e.g.*, OpenStreetMap, Google Earth to objectively measure the social preferences towards sites with diverse benefits that are either intangible or non-utilitarian. Within the scope of the presented case study, the traveling manners evaluated were relatively simplified, given the predominant status of motorbikes within the research area. This, however, placed a significant ground for further exploration of methods, in which, the connections of different means of transportation being developed, hence more explicitly numerate the Willingness of Respondents. Last but not least, it is suggested that the research findings be transferable to certain policies, paving the way for the sustainable management of landscape cultural values and benefits.

Another noteworthy point is the demonstrated roles of political actors within the overall gameplay of ES. From the achievements of the USA 2015 Whitehouse Directive; to the revealed

opportunities in improving land pricing in Vietnam, policy relevance is found to as important as the technical measurements, if not the prerequisite for the applicability of ES. In other words, researchers should refrain from the prejudice of staying independent from the policy settings. Rather, they are encouraged to design their studies in such a way that scientific findings can resonate deeply with the standards of policies, regulations to facilitate dialogues with decision makers and explore opportunities for improvements. Of similar relevance to policies, the combination of ES knowledge and other environment decision support tools is worth exploring. For instance, the integration of ES evaluation into environment impact assessments, those with well-established legal basis could essentially ease the way of mainstreaming. At the other end, the additional information provided by ES knowledge can clarify and enrich the environment assessments. Within the literature, this idea of combination has only been associated with industrialized nations, providing excellent research opportunities for future studies.

LIST OF PUBLICATIONS

A. *Published*

1. **Loc, Ho Huu**, Kim N. Irvine, Nguyen Thi Hong Diep, Nguyen Thi Kim Quyen, Nguyen Ngoc Tue, and Yoshihisa Shimizu. "The Legal Aspects of Ecosystem Services in Agricultural Land Pricing, Some Implications from a Case Study in Vietnam's Mekong Delta." *Ecosystem Services*, In Press, December 2016.

2. **Loc, Ho Huu**, Nguyen Thi Hong Diep, Nguyen Trong Can, Kim N. Irvine, and Yoshihisa Shimizu. 2016. "Integrated Evaluation of Ecosystem Services in Prawn-Rice Rotational Crops, Vietnam." *Ecosystem Services*. In Press. May, 2016.

B. *Submitted*

3. **Loc, Ho Huu**, Kim N. Irvine, Ashim Das Gupta, Nguyen Thi Hong Diep, and Yoshihisa Shimizu. "Ecosystem Services for Effective Decision Making: Prospects, Caveats, and Recognizing Ways Forward." (Submitted to *Journal of Environmental Management* on March 2017)

4. **Loc, Ho Huu**, Thomas J. Ballatore, Kim N. Irvine, Nguyen Thi Hong Diep, Truong Thi Cam Tien, and Yoshihisa Shimizu. "Socio-geographical indicators to support the quantification and assessment of Recreational and Spiritual Ecosystem Services." (Submitted to *Ecosystem Services* on April 2017)

5. **Loc, Ho Huu**, Nguyen Thi Hong Diep, Vo Thanh Tuan, and Yoshihisa Shimizu. "An analytical approach in accounting for Social Values of Ecosystem Services in a Ramsar Site: a case study in Mekong Delta, Vietnam." (Submitted to *Ecological Indicators* on April 2017)

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